User's Guide

# HP 85714A **Scalar** Measurements Personality

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# Scalar measurements with the HP 85714A

The HP 85714A scalar measurements personality provides a portable easy-to-use solution for making scalar measurements. The HP 85714A installs in any HP 8590 Series Option 010 spectrum analyzers. (Option 010 spectrum analyzers have built-in tracking generators.) Depending on your spectrum analyzer, you can perform transmission measurements in the following frequency range:

| | |
|---|---|
| HP 8590B | 100 kHz to 1.8 GHz |
| HP 8590D | 100 kHz to 1.8 GHz |
| HP 8590L | 100 kHz to 1.8 GHz |
| HP 8591A | 100 kHz to 1.8 GHz |
| HP 8591C | 1 MHz to 1.8 GHz |
| HP 85913 | 100 kHz to 1.8 GHz |
| HP 8593A | 300 kHz to 2.9 GHz |
| HP 85933 | 300 kHz to 2.9 GHz |
| HP 8594A | 300 kHz to 2.9 GHz |
| HP 85943 | 300 kHz to 2.9 GHz |
| HP 8595A | 300 kHz to 2.9 GHz |
| HP 85953 | 300 kHz to 2.9 GHz |
| HP 85963 | 300 kHz to 2.9 GHz |

Reflection measurements are possible when the spectrum analyzer/HP 85714A combination is used with an HP 85630A transmission/reflection test set.

**One-button measurement solutions.**

The HP 857148 offers one-button measurement solutions that allow you to measure parameters such as:

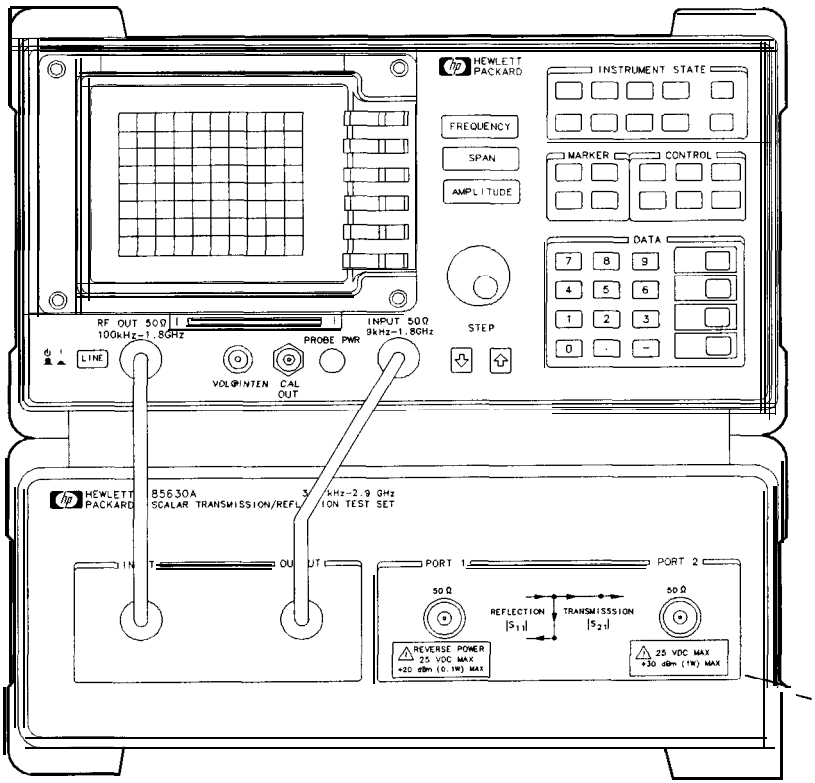
- transmission coefficient
- reflection coefficient
- VSWR
- insertion loss
- bandwidth
- shape factor
- Q

Using limit lines, you can implement pass/fail testing.

Once installed, the features of the HP 85714A scalar measurements personality are accessed via front-panel keys and softkeys.

Required spectrum analyzer:

| | |
|---|---|
| HP 8590B | OPTIONS 003 AND 010 |
| HP 8590D | OPTIONS 003 AND 010 |
| HP 8590L | OPTIONS 003 AND 010 |
| HP 8591A | OPTION 010 |
| HP 8591C | OPTION 010 |
| HP 85913 | OPTION 010 |
| HP 8593A | OPTION 010 |
| HP 85933 | OPTION 010 |
| HP 85948 | OPTION 010 |
| HP 85943 | OPTION 010 |
| HP 8595A | OPTION 010 |
| HP 8595E | OPTION 010 |
| HP 85963 | OPTION 010 |




OPTIONAL
**HP** 85630A **SCALAR TRANSMISSION/ REFLECTION TEST SET**

PV21A

**To make a measurement.**

1. Install the HP 85714A as shown in Chapter 1.
2. Set the frequency and amplitude parameters as shown in Chapter 2.
3. Perform a calibration as shown in Chapter 3.
4. Measure the response as described in Chapter 4.

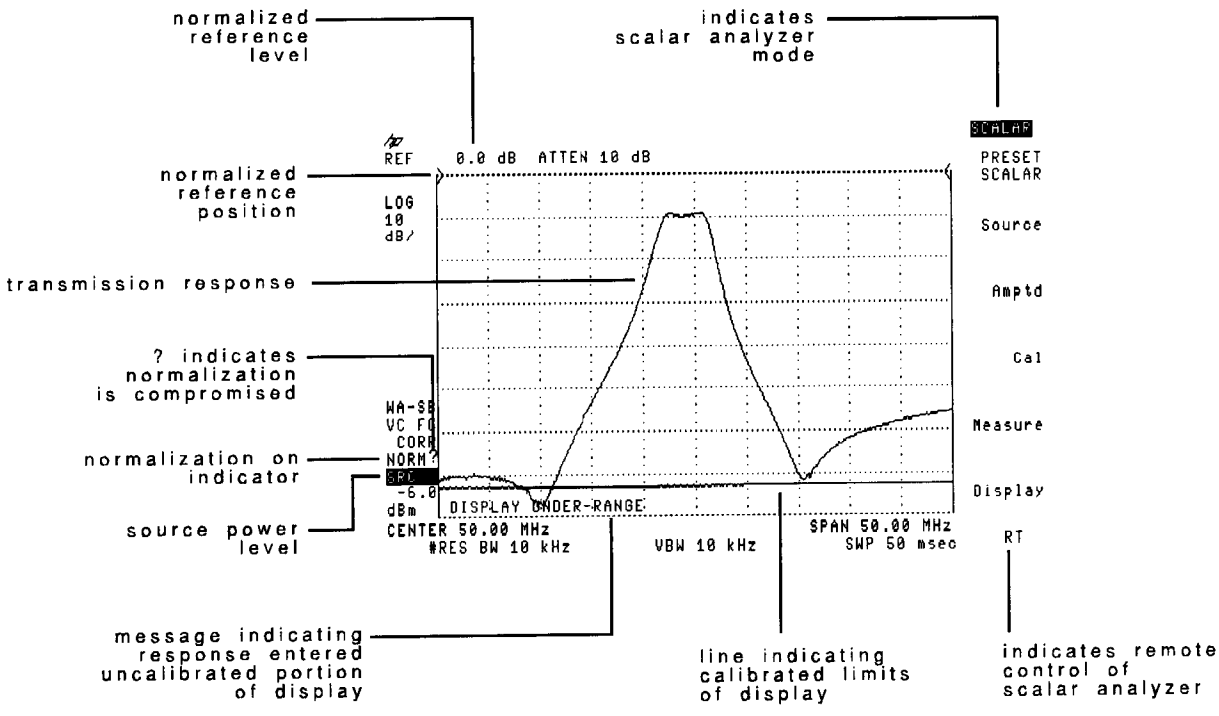
**External tracking generators**

The HP 85714A scalar measurements personality is designed to use the spectrum analyzer's internal tracking generator. Although external tracking generators can be used, the HP 85714A cannot control them.

**Calibration kit**

Reflection calibration requires both *open* and *short* standards. The HP 85032B Option 001 Calibration Kit supplies 50Ω type N *open* and *short* standards for calibration.

**Scalar measurement mode screen annotation.**




**Scalar menu entry**

When pressed, some front-panel keys exit you from the HP 85714A's menus. To return to an HP 85714A's menu, press the front-panel (MODE) key twice. (You can also press one of the many front-panel keys that lead to an HP 85714A menu.)

**Redefined front-panel keys.**

While in the scalar measurement mode, many of the front-panel keys invoke new softkeys menus. Refer to Chapter 8, "Reference," for menu maps showing the changed keys.

**Optional HP 85630A Scalar Transmission/Reflection Test Set.**

The optional HP 85630A scalar transmission/reflection test set greatly reduces the setup time required for reflection measurements. The test set also allows you to make simultaneous transmission and reflection measurements without having to change the equipment setup. The scalar measurements personality controls the scalar test set via the spectrum analyzer's rear-panel AUX INTERFACE connector.

**Memory allocation.**

The HP 85714A scalar measurements personality stores calibration and limit line data in trace memory. Therefore, when saving traces use caution to avoid overwriting calibrations or limit lines. Before saving traces, use the spectrum analyzer's catalog feature to determine which trace registers are available for data.

**Reflection measurements.**

The optional HP 85630A scalar transmission/reflection test set provides the necessary external bridge needed to perform reflection measurements. If you don't have the HP 85630A, you will need to connect the necessary bridge and cables to perform the measurement.

In addition to providing a bridge, the test set allows you to perform both transmission and reflection measurements using the same setup. There's no time consuming equipment changes.

# In this book

This book provides all the information needed to install and operate the HP 857148 scalar measurements personality and the HP 85630A scalar transmission/reflection test set.

Softkeys are indicated by a boxed word written in a shadow typeface.

Chapter 1, "Quick Start Guide, " explains how to install the personality and guides you through some simple scalar measurements.

Chapters 2 through 7 describes how to perform measurements using the scalar measurement mode.

Chapter 8, "Reference," lists reference material in a easy-to-find manner.

Chapter 9, "Concepts," is a technical discussion on scalar measurement accuracy.

Chapter 10, "If You Have a Problem" provides solutions for problems you may encounter.

**Spectrum analyzer operation**

If you are not familiar with your spectrum analyzer, refer to the spectrum analyzer's installation and operation and programming manuals. These manuals describe spectrum analyzer preparation and verification, and tell you what to do if something goes wrong. Also, they describe spectrum analyzer features and tell you how to make spectrum analyzer measurements. Consult these manuals whenever you have a question about standard spectrum analyzer use.

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# 1

# Quick Start Guide

# Quick Start Guide

Use the steps in this chapter to install the HP 85714A scalar measurements personality and the optional HP 85630A scalar transmission/reflection test set. These steps also introduce you to some basic measurement features.

You can complete this chapter in about 20 minutes. For instructional purposes, a 50 MHz bandpass filter is used. You can easily substitute your own filter or other device by simply adjusting the frequencies used in these procedures.

# Before you begin

- To install the HP 85714A and skip the tutorial steps, perform only step 2.
- Perform steps 1 and 7 through 10 only if you have an HP 85630A test set.

**CAUTION**

Do not connect or disconnect the HP 85630A test set's control cable to the spectrum analyzer's rear-panel AUX INTERFACE connector while power is on. Connecting or disconnecting the cable while power is applied may result in loss of factory correction constants.

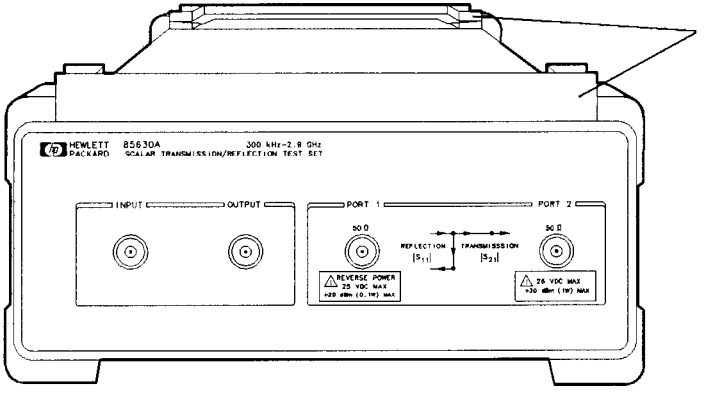
# Step 1. Connect the optional HP 85630A test set

1 Turn the spectrum analyzer off, and remove the line-power cord.

CAUTION: loss of factory correction constants may result if the spectrum analyzer is powered while connecting or disconnecting th rear-panel AUX INTERFACE cable.

You may notice the test set's front-panel PORT 2 connector has a small amount of movement. This is *not* a mechanical fault. The movement is designed to make connecting semirigid cables easier.

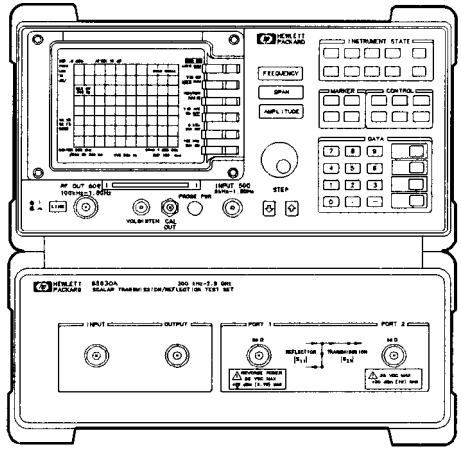
2 Place the two stacking support shoes on the top of the HP 85630A.




STACK I NG SUPPORT SHOES

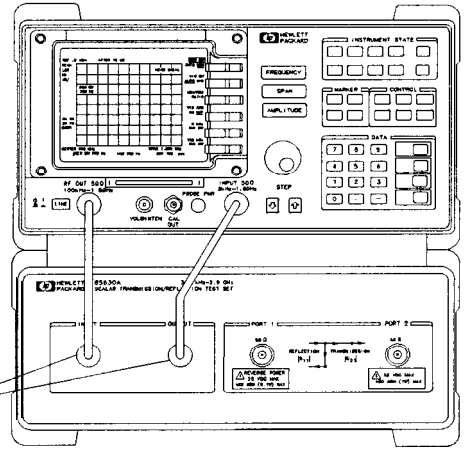
PV21

3 Set the spectrum analyzer on top of the stacking support shoes.



PV23A

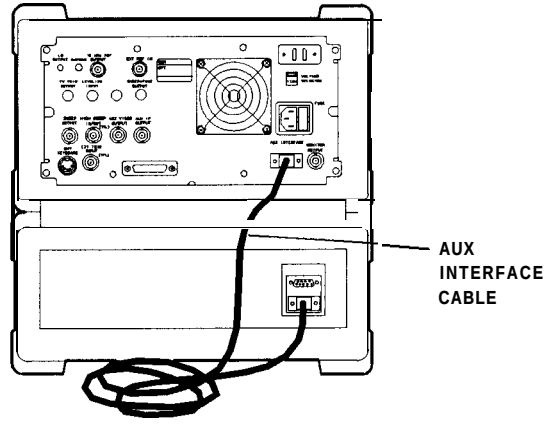
4 Connect the front-panel semirigid cables.




PV24A

**Step 1. Connect the optional HP 85630A test set**

5 Connect the rear-panel auxiliary interface cable.

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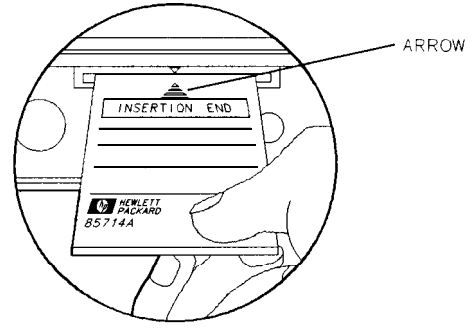
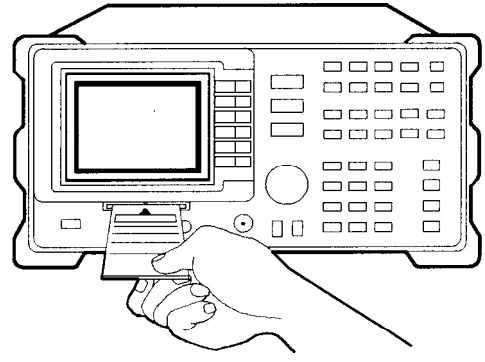
6 Connect the line-power cord to the spectrum analyzer, end turn the power on.

# Step 2. Load the personality

**1** locate the arrow printed on the HP 85714A card's label.

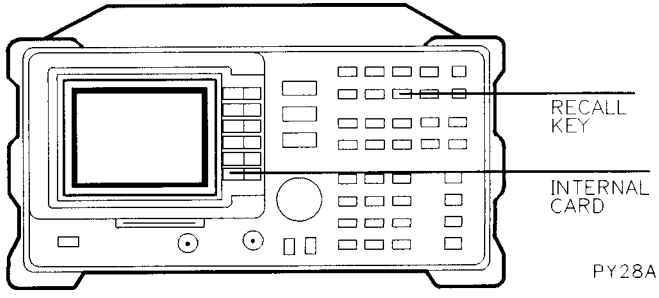



2 Insert the card into the spectrum analyzer with its arrow matching the raised arrow on the bezel around the card-insertion slot.



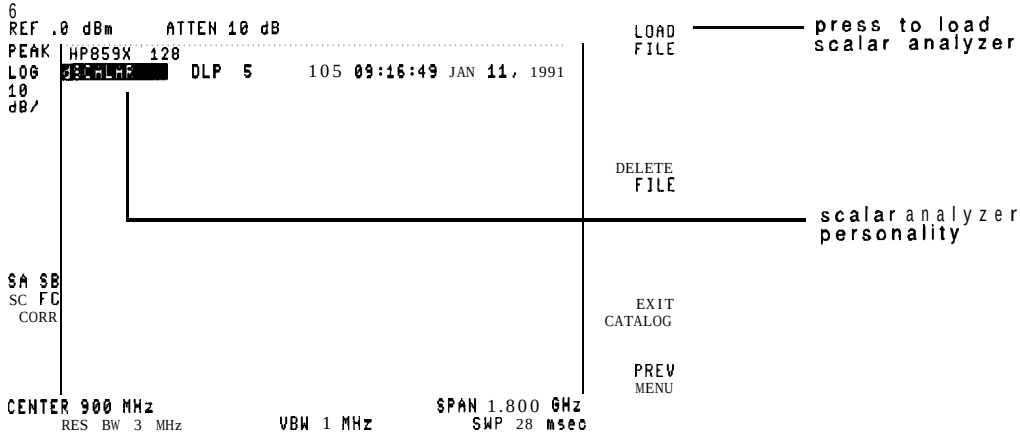
**Step 2. load the personality**

3 On the spectrum analyzer, press (RECALL). Press the INTRNL CRD softkey so that CRD is underlined.

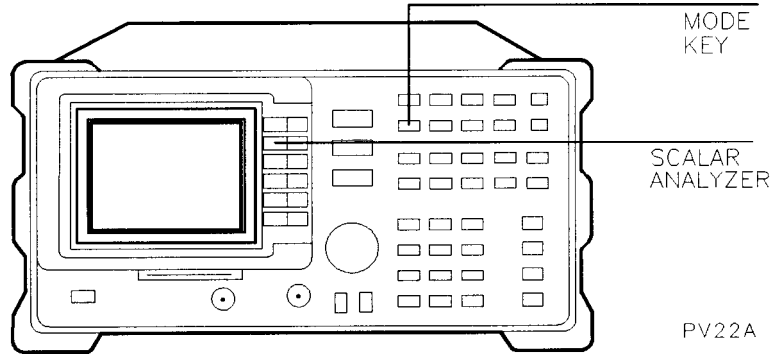



4 Press the following softkeys to load the HP 85714A: CATALOG CARD , MORE 1 OF 2, CATALOG DLP , end LOAD FILE.

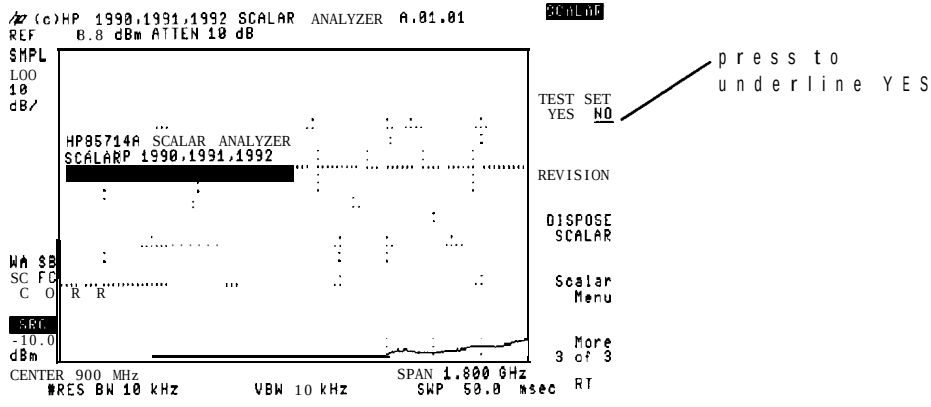
This step takes about 1 minute to complete. If INVALID SYMTAB ENTRY: SYMTAB OVERFLOW is displayed, refer to Chapter 10, "If You Have a Problem."



Press (MODE) and then SCALAR ANALYZER.



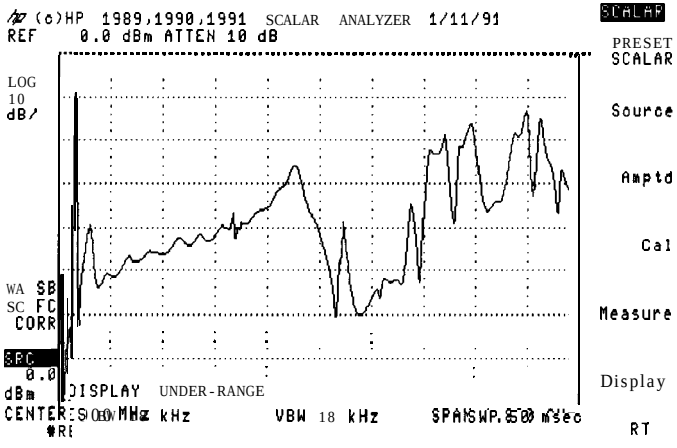

i Press the TEST SET YES NO softkey so that YES is underlined.




l The scalar measurements personality is now configured for the test set. Turning the spectrum analyzer off or removing the line power does not alter this configuration.

**Step 2. load the personality**

9 Remove the card from the spectrum analyzer.




scalar analyzer main menu softkeys

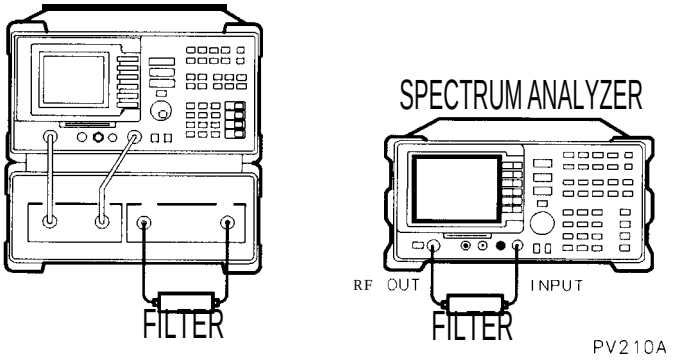
# Step 3. Calibrate a transmission measurement

This step calibrates the scalar measurements personality for measuring transmission through a filter.

1. Connect a short, low-loss cable between the input and output
   - If you are using the HP 85630A, connect between Port 1 and Port 2.
   - If you are using a spectrum analyzer, connect between RF OUT and INPUT.
2. Press (FREQUENCY), and set the center frequency. Our example is 50 MHz.
3. Press (SPAN), and set the spanwidth. Our example is 50 MHz.
4. Press the (CAL) key and then the CAL THRU softkey.

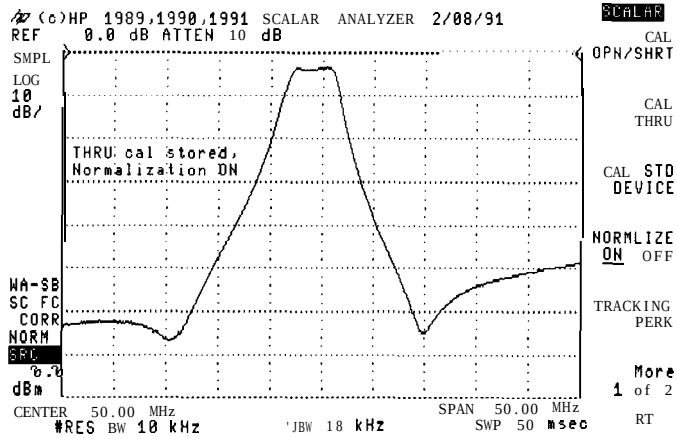
   This enters a guided calibration routine. This routine normalizes the system response thus eliminating system errors from any measurements.
5. Press the STORE THRU softkey.

# Step 4. Display the response full screen




1. Connect a bandpass filter between the input and output.
   - If you are using the HP 85630A, connect between Port 1 and Port 2.
   - If you are using a spectrum analyzer, connect between RF OUT and INPUT.

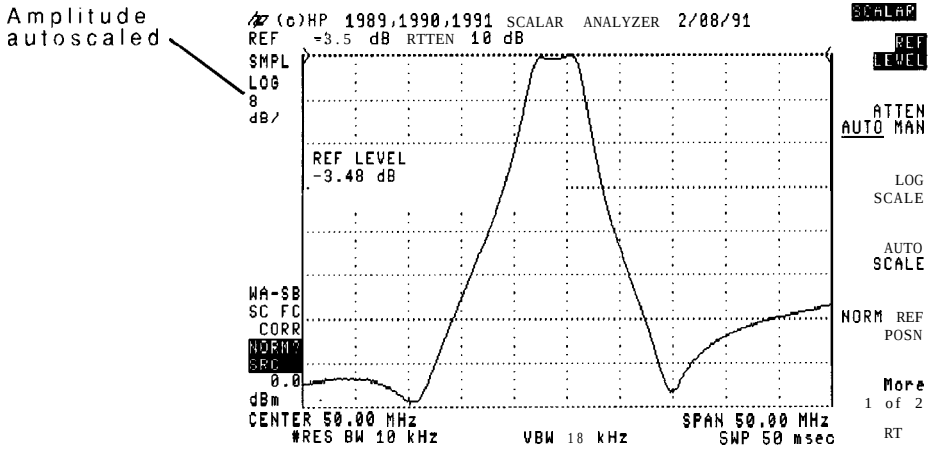
The response should appear similar to the following figure.




2. Press the AMPLITUDE key.

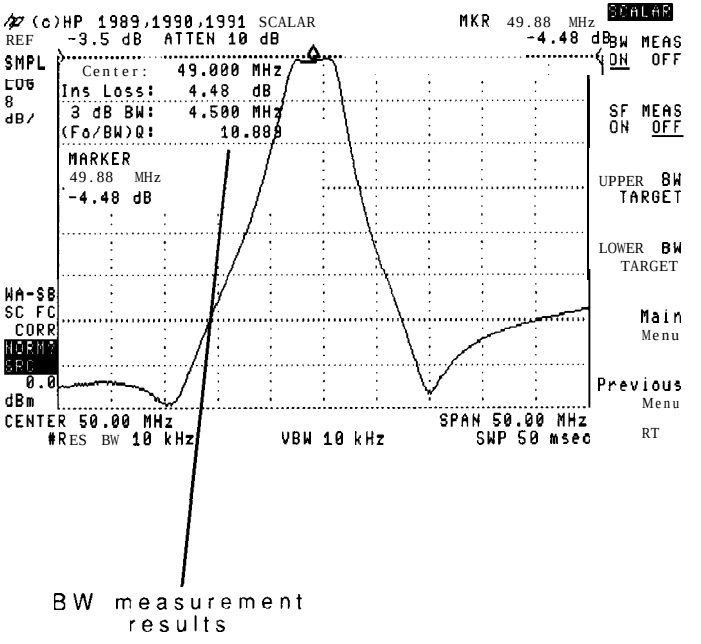
3. Press the AUTO SCALE softkey.

The response peak is automatically placed at the normalized reference level, and the vertical log scale is adjusted to view the response as large as possible.



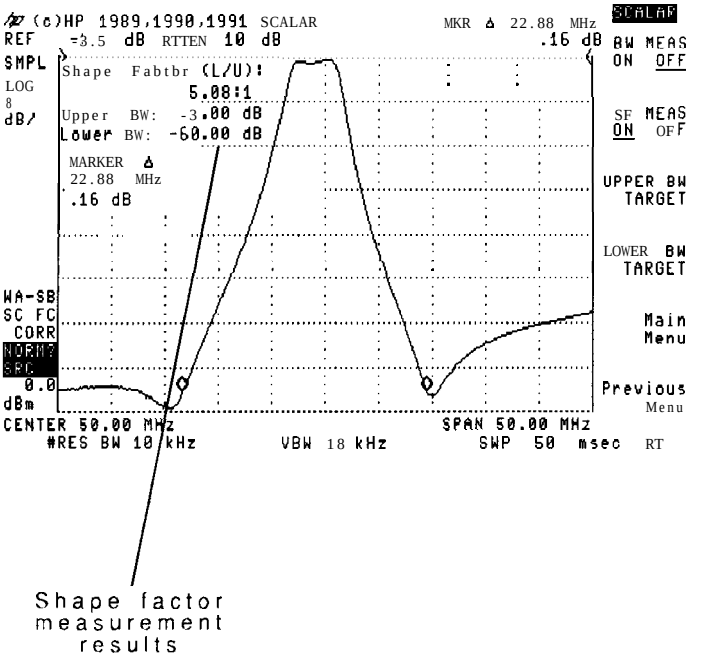
# Step 5. Measure the filter's passband

1. Press the (MEAS/USER) key followed by the Device BW **Meas** softkey.
2. Press the BW **MEAS** ON OFF softkey so that ON is underlined.
3. The display shows the filter's center frequency, insertion loss, 3 dB bandwidth, and Q.




4. Press the SF **MEAS** ON OFF softkey so that ON is underlined.

5. The display shows the filter's shape factor (lower bandwidth divided by upper bandwidth).




6. Press the SF MEAS ON OFF softkey so that OFF is underlined.

7. To turn the markers off,

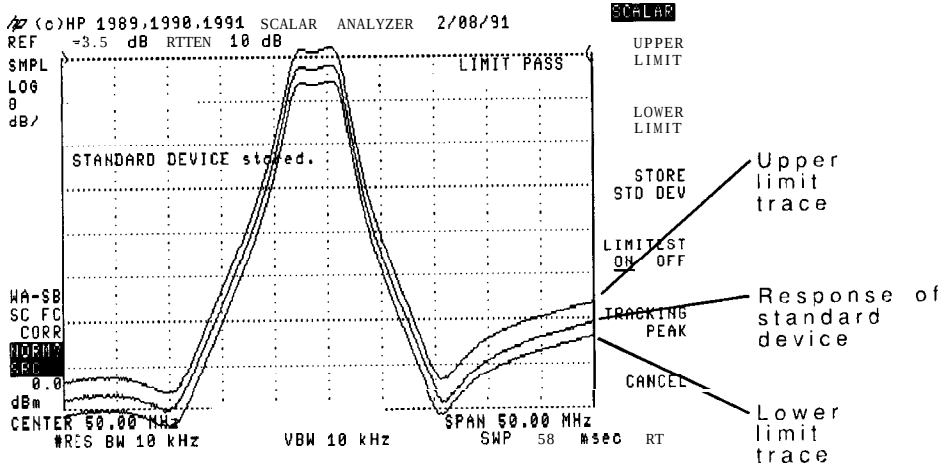
   - If you are using an HP 8590B, HP 8591A, HP 5893A, HP 8594A, or HP 8595A, press the (MKR) then MARKERS OFF softkey.
   - If you are using an HP 8590D, HP 85913, HP 85933, HP 85943, HP 85953, or HP 85963, press the (MKR), then More, 1 of 2 , and then the MARKERS ALL OFF softkey.

# Step 6. Set up standard device testing

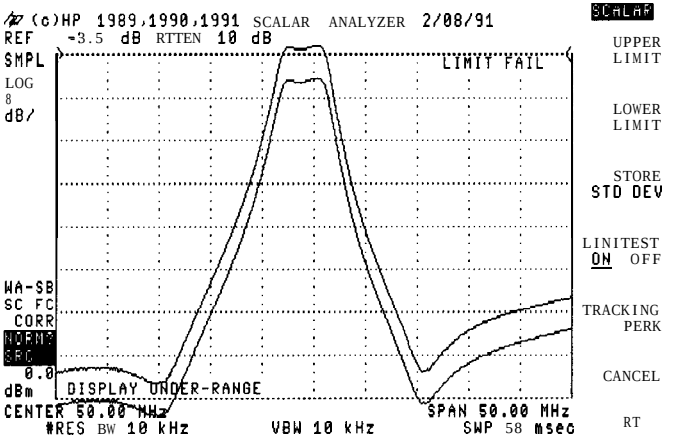
Standard device testing automatically creates and displays test limits for a "standard" device. Similar devices can then be compared to the standard response. This feature is very useful in repetitive production-line testing.

1. Press the CAL key followed by the CAL STD **DEVICE** softkey.

2. With the filter still connected to the spectrum analyzer, press the STORE STD **DEV** softkey. The spectrum analyzer displays upper and lower limit traces that are parallel to the standard devices response.



3. Remove the filter and observe the limit traces displayed on the screen. The UPPER LIMIT and LOWER LIMIT softkeys define the placement of the limit traces.

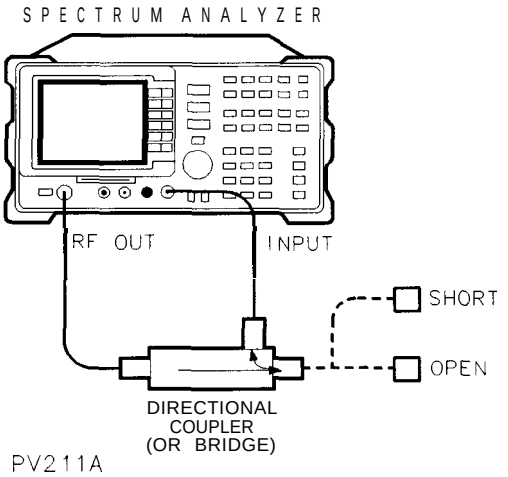


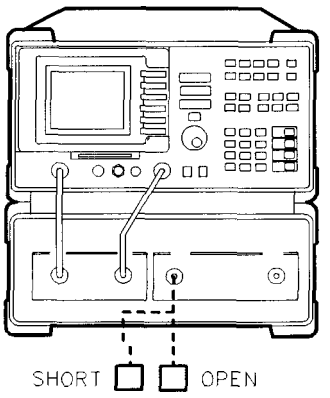

4. Press the LIMITEST ON OFF softkey so that OFF is underlined.

# Step 7. Calibrate a transmission measurement

1. Connect a short, low-loss cable between the input and output.
   - If you are using the HP 85630A, connect between Port 1 and Port 2.
   - If you are using a spectrum analyzer, connect between RF OUT and INPUT.
2. Press [FREQUENCY), and set the center frequency. Our example is 50 MHz.
3. Press (SPAN), and set the span width. Our example is 50 MHz.
4. Press the (CAL) key and then the CAL THRU softkey.
5. Press the STORE THRU softkey.

# Step 8. Calibrate a reflection measurement



**Reflection Measurements**

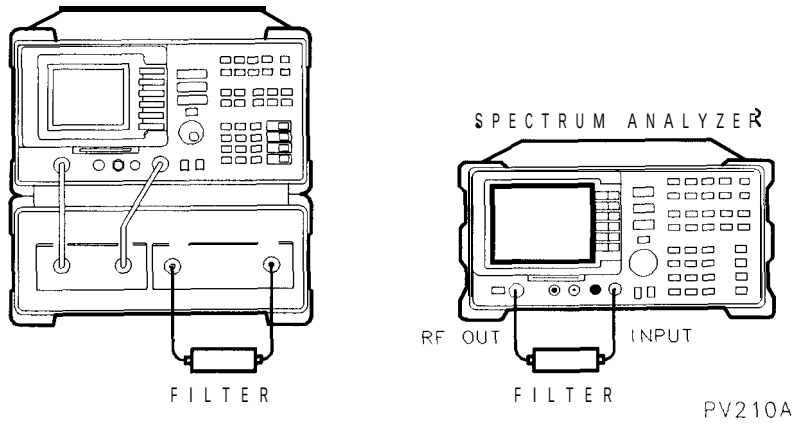
In order to measure reflection, a directional signal splitting device, such as a coupler, bridge, or the HP 85630A test set is required.

1. Press the CAL OPN/SHRT softkey.
2. Connect an *open* to the measurement port, and then press STORE OPEN

   The measurement port may be from the coupler, bridge, or the HP 85630A test set.

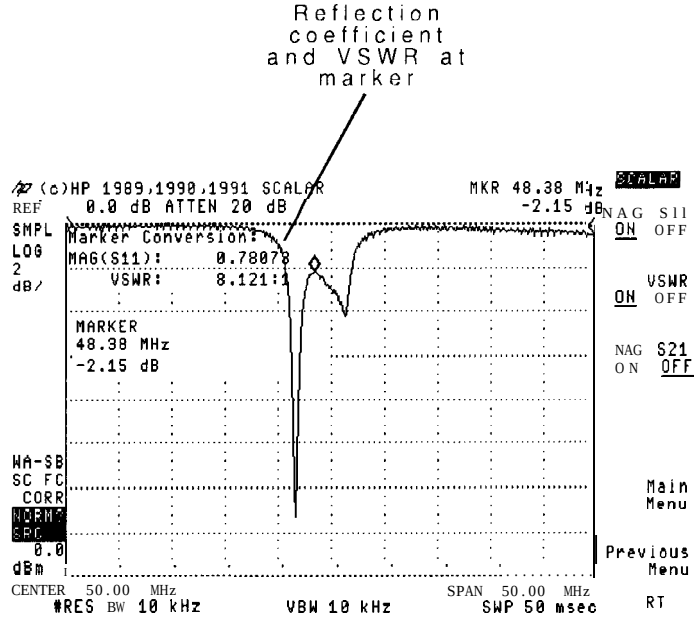
   It is good practice to place the *open* at the end of any cable used to connect PORT 1 to the device being tested. This moves the calibration to the plane of measurement.
3. Remove the *open* and replace it with a short.
4. Press the STORE SHORT softkey.
5. Remove the short.

# Step 9. Measure reflection coefficient and VSWR



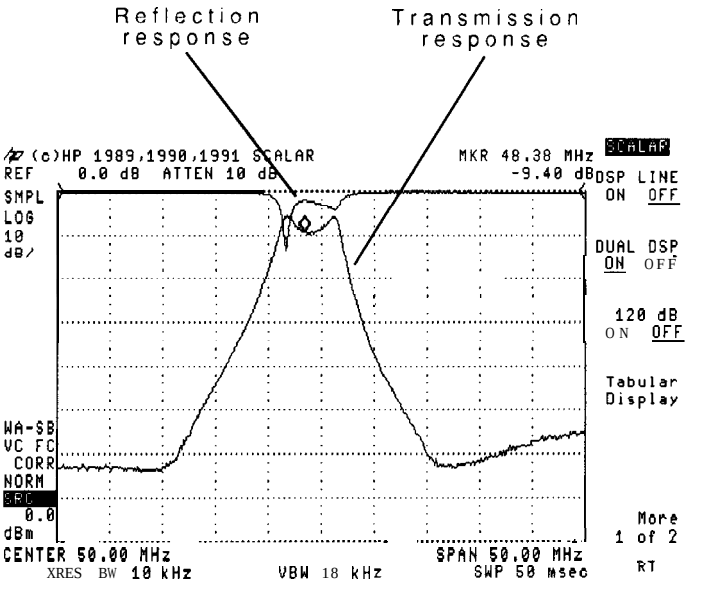

1. Connect the bandpass filter between the input and output.
   - If you are using the HP 85630A, connect between Port 1 and Port 2.
   - If you are using a spectrum analyzer, connect between RF OUT and INPUT.
2. Press the (AMPLITUDE) key.
3. Press the AUTO SCALE softkey.
4. Press the (MEAS/USER) key, and then Marker Convert softkey.
5. Press the **MAG S11** ON OFF softkey so that ON is underlined.
6. Press the **VSWR** ON OFF softkey so that ON is underlined.
7. The reflection coefficient and VSWR at the marker is displayed on the screen.

   Use the front-panel knob to move the marker and read the value at any point.




8. Press the **MAG S11** ON OFF softkey so that OFF is underlined.
9. Press the VSWR ON OFF softkey so that OFF is underlined.
10. Press the AMPLITUDE key and then the LOG SCALE softkey.
11. Set the log scale back to 10 dB per division.

# Step 10. View transmission and reflection results



**Simultaneous Results**

In order to simultaneously view reflection and transmission results, an HP 85630A is required.

1. Press the (MEAS/USER) key, and view the reflection response.
2. Press the TRANS softkey to view the transmission response.
3. Press the (DISPLAY) key followed by the DUAL DSP ON OFF softkey to view both the reflection and transmission responses at the same time.

   If the filter is adjustable, you can adjust it while observing the resulting transmission and reflection responses in near real time. The scalar measurements personality updates the traces on alternating sweeps.
4. Press the DUAL DSP ON OFF softkey so that OFF is underlined.

**Configuration Error**

If the error message "85630A TEST SET CONFIGURATION REQUIRED" is displayed, the scalar personality must be configured. Press (CONFIG), More 1 of 3, More 2 of 3, then TEST SET YES NO so that YES is underlined.

2

# Preparing for Measurements

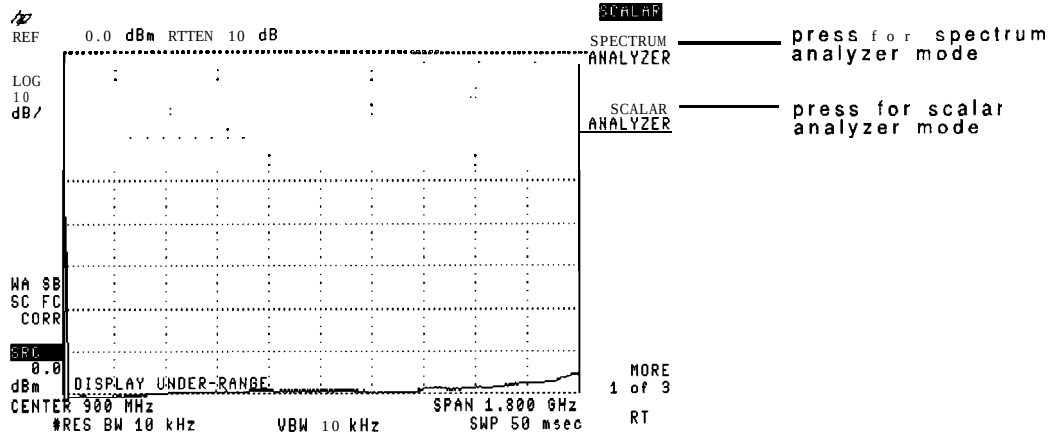
# Preparing for Measurements

This chapter teaches the basic controls for the scalar measurements personality. To use the scalar measurements personality, you must first install it, refer to Chapter 1, then change to scalar analyzer mode.

# Changing scalar analyzer mode

In this section, you'll learn how to start, preset, exit, and remove the scalar measurements personality. Information on finding the HP 85714A's revision number is also included. If you followed the instructions in Chapter 1, the scalar measurements personality should already be installed and in the active mode.

To use the scalar measurements personality, you must first change the spectrum analyzer to scalar analyzer mode. You can switch your instrument between signal analyzer and scalar analyzer operation at any time. This is accomplished by pressing the front-panel (MODE) key, and using softkeys displayed shown below:




**Main menu**

Enter the scalar measurements personality's Main menu at any time by pressing (MODE) SCALAR ANALYZER.

The HP 85714A scalar measurements personality does *not* need to be reinstalled after switching between the two modes of operation. However, if you remove the HP 85714A scalar measurements personality as shown in this section, you'll need to reinstall it using the procedure in Chapter 1.

Presetting the scalar measurements personality returns it to a known start-up state. *PRESET SCALAR* in Chapter 8 provides information on the preset state.

## To enter scalar analyzer mode

1. Press the front-panel (MODE) key.
2. If the SCALAR ANALYZER mode softkey does not appear, press (MODE) again.
3. Press the SCALAR ANALYZER softkey.

## To return to spectrum analyzer mode

1. Press the front-panel (MODE) key.
2. Press the SPECTRUM ANALYZER softkey.

## To preset the scalar measurements personality

1. Press the MODE key.
2. Press Scalar Analyzer to enter the main menu.
3. Press the PRESET SCALAR softkey.

## To remove the HP 85714A

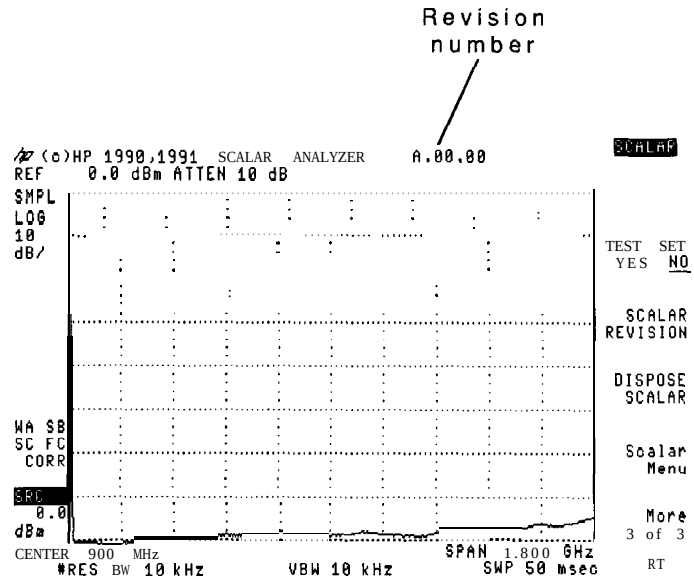
1. Press the front-panel CONFIG key.
2. Press the MORE 1 of 3 and then MORE 2 of 3 softkeys.
3. Press the DISPOSE SCALAR softkey twice.

This procedure removes the HP 857148 from the spectrum analyzer's memory. You must reinstall the HP 85714A to use it again.

# Viewing the revision number

The scalar measurements personality's revision number is available via softkeys. It is used by the factory to indicate the vintage of the program. You may be asked for this number when requesting help from Hewlett-Packard.

# To view the HP 85714A revision number




1. Press the front-panel CONFIG key.
2. Press the MORE 1 of 3 and then MORE 2 of 3 softkeys.
3. Press the SCALAR REVISION softkey.
4. The revision number is displayed at the top of the display.

# Controlling the frequency

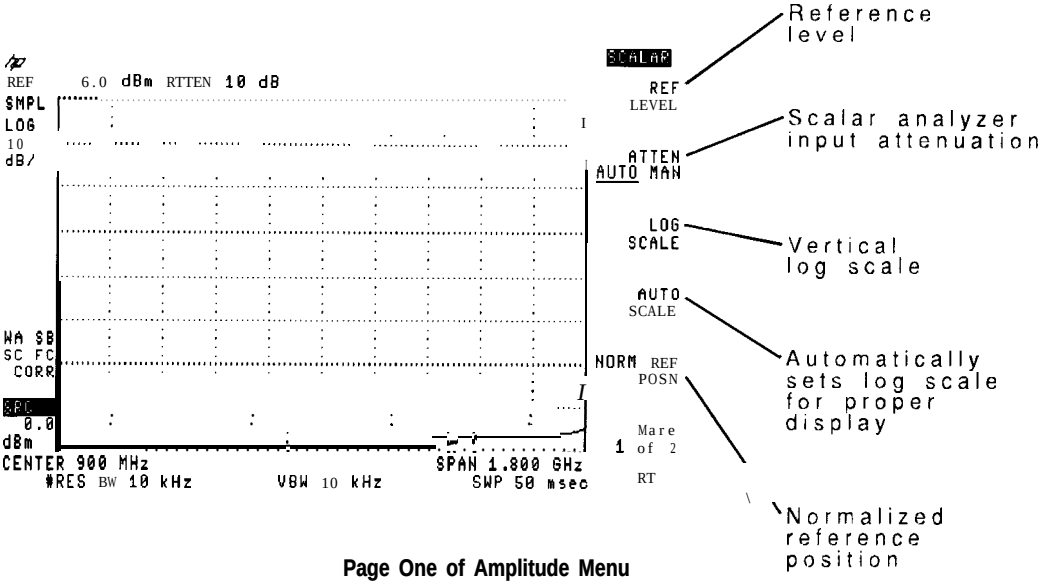
The scalar measurements personality uses the spectrum analyzer's built in tracking generator as the RF source. The tracking generator's output tracks the scalar analyzer's input frequency.

Set the scalar analyzer's frequency using the front-panel [FREQUENCY] and [SPAN] keys. The tracking generator's output frequency tracks the scalar analyzer's frequency. So, by setting the scalar analyzer's frequency you control the tracking generator.

## To sweep the frequency

1. Press the front-panel (FREQUENCY) key.
2. Use the front-panel knob or numeric keypad to set the center frequency.
3. Press the (SPAN) key.
4. Use the front-panel knob or numeric keypad to set the frequency span.

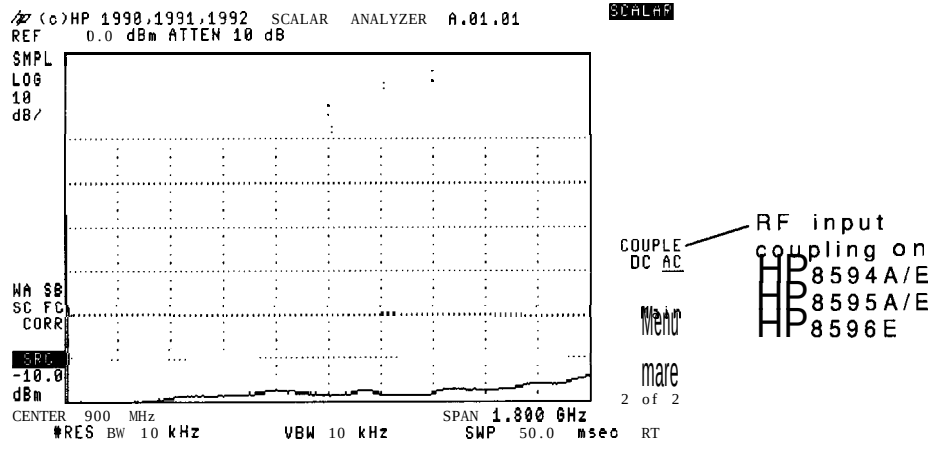
The Amplitude menu allows you to control the scalar analyzer's vertical scale, reference level, and normalized trace position. To enter the Amplitude menu, press the front-panel (AMPLITUDE) key or press the main menu's Amptd softkey.




**Page One of Amplitude Menu**

Any changes in the reference level should be made before measurement calibration. To change the reference position after calibration, use NORM REF POSN Refer to Chapter 3 for information on calibrating for measurements.

For best measurement accuracy, place the peak signal response at the reference level. The AUTO SCALE softkey automatically sets the vertical scale to show a displayed response. Use this softkey after calibration.




**Page Two of Amplitude Menu**

## To change the reference level

1. Press the front-panel [AMPLITUDE] key.
2. Press the **REF** LEVEL softkey.
3. Use the front-panel knob or numeric keypad to set the new reference level.

## To change the amplitude scale

1. Press the front-panel [AMPLITUDE] key.
2. Press the LOG SCALE softkey.
3. Use the front-panel knob or numeric keypad to change the amplitude scale. The default log scale is set to 10 dB per division.

# Changing the input attenuation

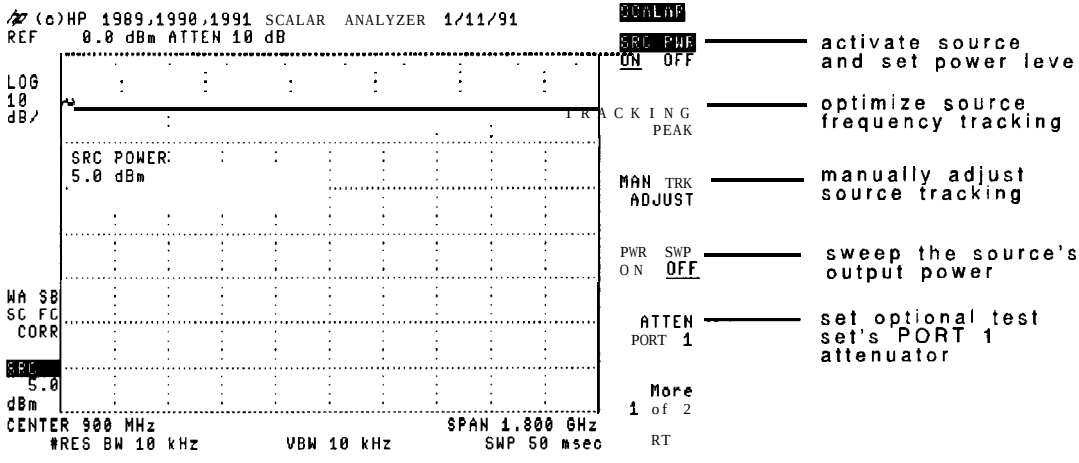
The scalar analyzer's input attenuator can be set in 10 dB increments. For HP 8590B and HP 8591A spectrum analyzers, the range is from 0 dB to 60 dB. For HP 8593A, HP 8594A, and HP 8595A spectrum analyzers, the range is from 0 dB to 70 dB. To protect the scalar analyzer, 0 dB attenuation can only be set using the numeric keypad (not the front-panel knob).

Input attenuation can be controlled automatically by the scalar analyzer personality or manually from the front-panel. Automatic coupling adjusts the attenuator to prevent compression of the input signal. Attenuation that is set manually is uncoupled from the reference level. (The reference level is limited at the high end by the manual attenuation setting. This limit is equal to -10 dBm plus the amount of RF attenuation.)

## To change the input attenuation

1. Press the front-panel (AMPLITUDE) key.
2. Press the **ATTEN** AUTO MAN softkey to activate the input attenuation.
3. Press the **ATTEN** AUTO MAN softkey until MAN is underlined.
4. Use the front-panel knob or numeric keypad to set the input attenuation.

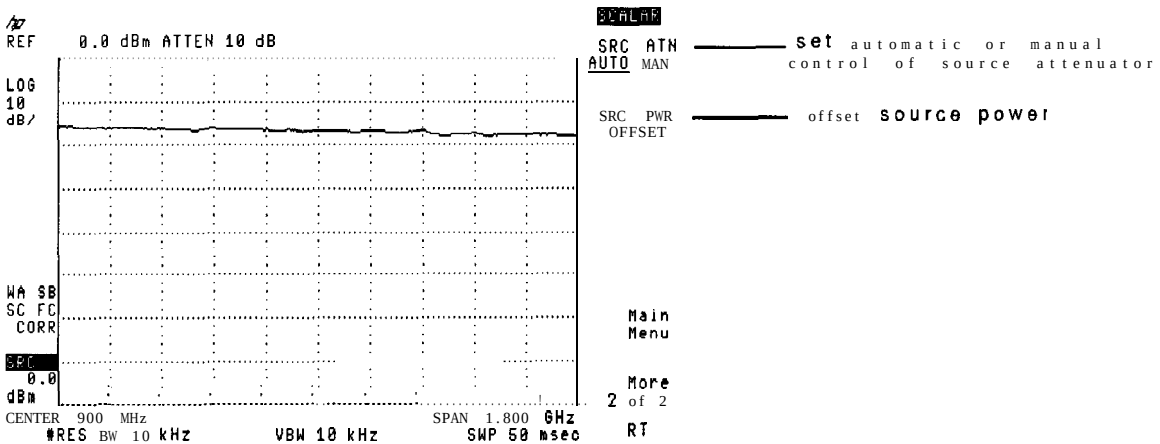
You control the built-in tracking generator through the Source menu. To enter the source menu, press the front-panel (AUX CTRL) key or use the scalar analyzer's main menu.




**Page One of Source Menu**

The source frequency tracks the input frequency of the scalar analyzer. To ensure accurate frequency tracking between the scalar analyzer and its tracking generator, press the TRACKING PEAK softkey in the CAL menu. Peaking the source is especially important at these times:

- Before a calibration.
- After temperature changes.
- After any resolution bandwidth changes.




**Page Two of Source Menu**

The amount of control over the source's output power depends on the spectrum analyzer used. See the following table for a summary of the options, power ranges and attenuations.

**HP 8590 Series Source Power Range and Attenuation**

| Model Number | Option | Power Range | Attenuation |
|---|---|---|---|
| **HP 85908, HP 8590D** | | | |
| | 010 | 0 to -15 dBm | None |
| | 011 | -6 to -21 dBm | None |
| **HP 8591A, HP 8591E** | | | |
| | 010 | 0 to -70 dBm | 0 to 60 dB |
| | 011 | -6 to -70 dBm | 0 to 60dB |
| **HP 8593A, HP 8594A, HP 8595A** | | | |
| | 010 | +1 to -10 dBm | None |
| **HP 8593E, HP 8594E, HP 8595E, HP 8596E** | | | |
| | **010** | -1 to -66 dBm | 0 to 56 dB |

Attenuation on the HP 8591A, HP 85933, HP 85943, HP 85953, and HP 85963 can be changed from 0 to 60 dB. With automatic control, the scalar analyzer sets the attenuation as necessary to maintain a calibrated display. The default setting is AUTO with 0 dB of attenuation and – 10 dBm source power.

The default setting after presetting the scalar analyzer is power on. Activating the SRC PWR ON OFF softkey makes the output power the active function.

## To turn on and set source power

1. Press the (AUX CTRL) key to enter the scalar analyzer's Source menu
2. Press SRC PWR ON OFF so that ON is underlined.
3. Use the front-panel knob or numeric keypad to set the source output power.

# Changing the source's attenuation

HP 8591A, HP 85933, HP 85943, HP 85953, and HP 85963 spectrum analyzers have output attenuators for the tracking generator. HP 8590B, HP 8590D, HP 8593A, HP 8594A, and HP 8595A spectrum analyzers do not have output attenuators.

Attenuation can be changed from 0 to 60 dB. In automatic mode, the scalar analyzer sets the attenuation as necessary to maintain a calibrated display. The default setting is AUTO with 0 dB of attenuation.

## To change source attenuation

1. Press the (AUX CTRL) key.
2. Press the More 1 of 2 softkey.
3. Press the SRC ATM AUTO MAN softkey to activate the function.
4. Press the SRC ATM AUTO MAN again so that MAN is underlined.
5. Use the front-panel knob or numeric keypad to set the source attenuation.

# Compensating for external gain or loss

Compensating for external gain or loss ensures that display readouts reflect the true power levels at the input to the device being tested.

For example, if the source power is 0 dBm, and 3 dB of loss occurs between the RF OUT connector and the device being tested, the display readouts show the power at the RF OUT connector. With the source power offset set to 3 dB, the displayed source power annotation indicates the power at the device being tested: -3 dBm.

Because output power is specified over a finite range, certain combinations of source power and source power offset can produce an uncalibrated or unleveled source output.

## To compensate for external gain or attenuation

1. Press the (AUX CTRL) key to enter the scalar analyzer's Source menu.
2. Press the More 1 of 2 softkey.
3. Press the SRC PWR OFFSET softkey.
4. Enter the amount of offset in dB. (Press the (ENTER) key to complete the entry.)

# Power sweeps

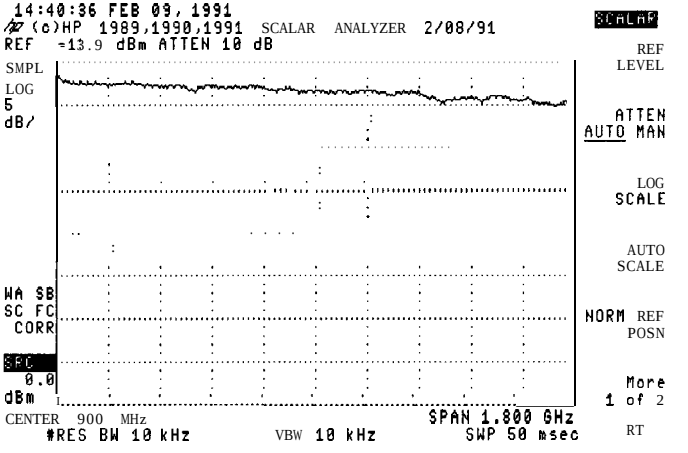
You can configure the scalar measurements personality for swept-power measurements. Power sweeps can be used in a zero frequency span or with frequency sweeps. As an example, use power sweeps to measure the 1 dB gain compression of a limiter. Or, use a power sweep to remove the slope from cable related losses. (You can compensate for roll off, but not roll up, with power sweeps.) Refer to the spectrum analyzer's operating manual for more information on power sweeps.

## To sweep the power

1. Press the (AUX CTRL) key to enter the scalar measurements personality's Source menu.
2. Use the front-panel knob or numeric keypad to enter the starting power for the sweep.
3. Press TRACKING PEAK softkey.
4. Press the PWR SWP ON OFF softkey twice so that ON is underlined.
5. Use the front-panel knob or numeric keypad to enter the amount in dB to sweep the power.

# To remove slope from the test setup

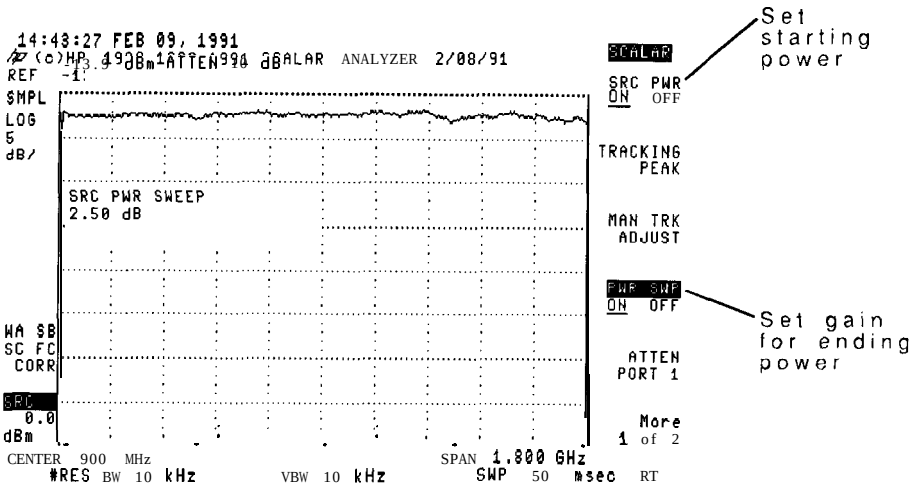
The scalar analyzer's power sweeps can be used to remove slope from the test setup. By sweeping the source's power level we can compensate for the system loss. The following figure illustrates slope caused by the frequency response of the system.



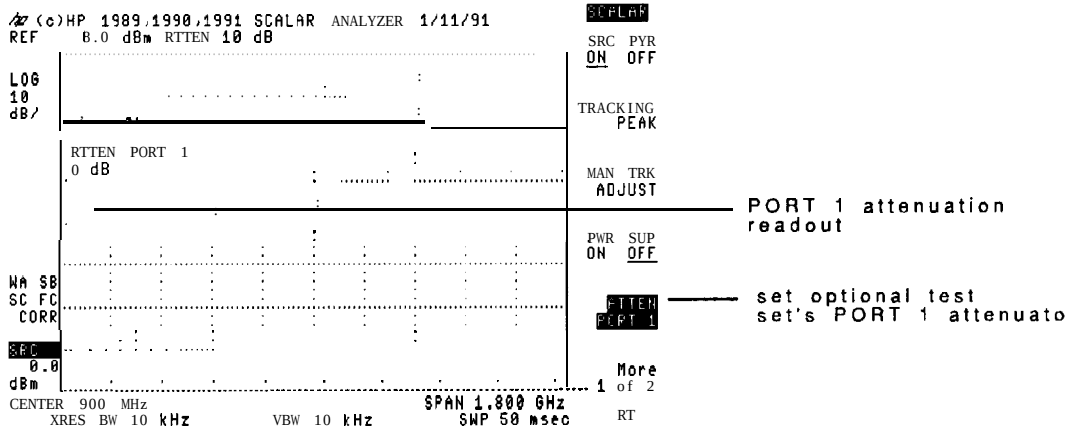

1. Press the (MKR) key, and place the marker at the start of the displayed response. This is the start power level.
2. Press the MARKER DELTA softkey, and place the delta marker at the other end of the display.

   The delta marker now reads the amount of loss or gain in the response over the entire viewed frequency range.
3. Press the (AUX CTRL) key to enter the Source menu.
4. Press the PWR SWP ON OFF softkey so that ON is underlined.
5. Enter the power gain or loss required at the end of the sweep relative to the start of the sweep.

This is equal to the negative of the value determined using the marker keys in the above steps. For example, if the delta marker reads -2.6 dB, enter +2.6 dB for the power sweep.



HP 85630A scalar transmission/reflection test set with Option 001 includes an output attenuator at PORT 1. You can change the attenuation from 0 to 70 dB in 10 dB steps.




You must inform the scalar analyzer if you have the optional HP 85630A scalar transmission/reflection test set connected. Refer to the following procedure. The scalar analyzer controls the test set through the auxiliary interface on the spectrum analyzer's rear panel.

## To turn on the test set

1. Press the front-panel (CONFIG) key.
2. Press the MORE 1 of 3 and then **MORE** 2 of 3 softkeys.
3. Press the TEST SET YES NO softkey so that YES is underlined.

Turning the test set on informs the scalar analyzer that the optional HP 85630A test set is attached.

## To change the test set's attenuation

1. Press the (AUX CTRL) key.
2. Press the More 1 of 2 softkey.
3. Press the **ATTEN** PORT 1 softkey.
4. Use the front-panel knob or numeric keypad to set the source attenuation from 0 to 70 dB.

HP 85630A scalar transmission/reflection test set must include Option 001. Standard test sets do not have the PORT 1 attenuator.

# AC/DC coupling

With HP 8594A, HP 85943, HP 8595A, HP 85953, and HP 85963 spectrum analyzers, you can select either AC or DC coupling between the INPUT connector and the internal circuits. Use the Amplitude menu's COUPLE AC DC softkey to select AC or DC coupling.

3

# Calibrating for Measurements

# Calibrating for Measurements

Measurement calibration is required before performing accurate reflection or transmission measurements. Calibration "normalizes" the test setup by canceling system frequency response.

# Using self-guided calibrations

The calibration procedures described in this chapter are self guided. They prompt you to make the necessary equipment connections. Using the Calibration menu you can:

- Calibrate reflection measurements.
- Calibrate transmission measurements.
- Calibrate standard device measurements.
- Turn normalization on or off.
- Save and recall calibrations.
- Show calibration ranges using display lines.
- Peak the tracking generator.

To enter the Calibration menu, press the front-panel CAL key or press the Main menu's Cal softkey.

**Calibration data**

Until saved, calibration data is stored in volatile memory and can be lost.

# Calibrating for maximum dynamic range

Maximum dynamic range is the amplitude range between the largest and smallest signal that can be measured simultaneously. Maximum dynamic range is especially important during transmission measurements.

## To ensure maximum dynamic range

1. Display the uncalibrated response of the device.
2. Reduce the spectrum analyzer's input attenuation and tracking generator's output attenuation to the lowest level possible. Use the maximum tracking generator power without causing signal compression.
3. Change the reference level so that the response is at the top of the display.
4. Perform the calibration as described in this chapter.

# Peaking the tracking generator

Peaking optimizes the source's frequency tracking. This ensures optimum frequency tracking between the RF OUT and the scalar analyzer's input frequency. Remember to peak the tracking generator before calibration.

## To peak the tracking generator

1. Press the front-panel (CAL) key.
2. Press the TRACKING PEAK softkey.

# Calibrating transmission measurements

During transmission calibrations, the device being tested is replaced with a through-line (cable). The resulting calibration cancels out the frequency response of the system including the cable. Use a low-loss cable with low VSWR to avoid introducing errors.

## To calibrate a transmission measurement

1. Set the scalar analyzer's frequency, span, output power, output attenuation, resolution bandwidth, and reference level for the desired response.
2. Connect a low-loss, low-VSWR, cable (thru line) between the front-panel RF OUT and INPUT connectors.

   If using the HP 85630A test set, connect the cable between the test set's PORT 1 and PORT 2 connectors.
3. Press the front-panel (CAL) key.
4. Press the TRACKING PEAK softkey.

   The scalar analyzer performs a short routine to optimize the frequency tracking of the tracking generator.
5. Press the CAL THRU softkey.
6. Press the STORE THRU softkey.

   Notice the "NORM" annotation in the lower-left corner of the display indicating the display is normalized.

# Calibrating reflection measurements

During Reflection calibrations, you terminate the line at the plane of reflection using an *open* and *short* connection. The plane of reflection is typically located at the input to the device being tested. Simply remove the device and replace it with the *short* or *open* as directed by the calibration routine.

**Calibration kit**

Reflection calibration requires both *open* and *short* standards. The HP 850328 Option 001 Calibration Kit supplies 50Ω type N *open* and *short* standards for calibration.

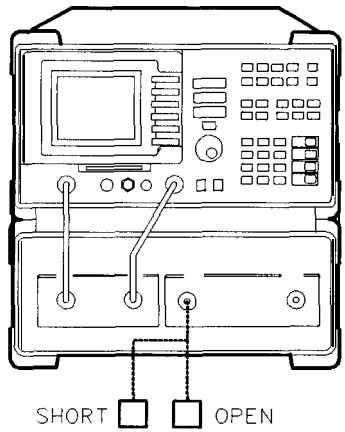
## To calibrate a reflection measurement

You must use an external bridge (test set) to make reflection measurements. The optional HP 85630A scalar transmission/reflection test set is the recommended test set.

1. Set the scalar analyzer's frequency, span, output power, output attenuation, resolution bandwidth, and reference level for the desired response.
2. Press the front-panel (CAL) key.
3. Connect a cable (thru line) between PORT 1 and PORT 2 of the HP 85630A test set.
4. Press the TRACKING PEAK softkey.

   The scalar analyzer performs a short routine to optimize the frequency tracking of the tracking generator.

5. Remove the cable from the path between the PORT 1 and PORT 2 connectors.
6. Press the **CAL OPN/SHRT** softkey.
7. Place an *open* connector on PORT 1 of the HP 85630A. This is the output of the bridge.




PV222

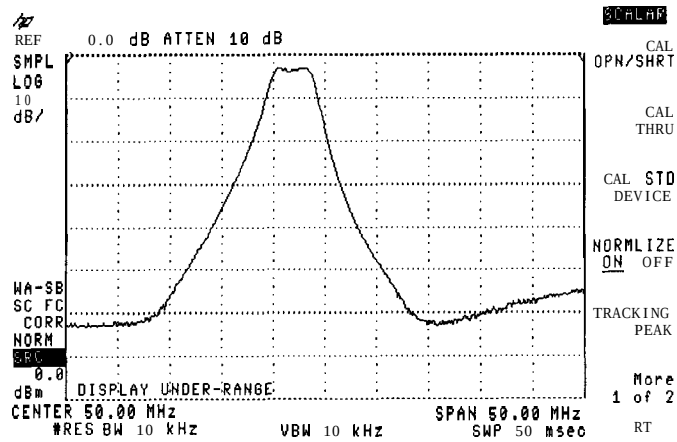
8. Press the **STORE OPEN** softkey.
9. Replace the *open* connector with a *short* connector.
10. Press the STORE SHORT softkey.

    Notice the NORM annotation in the lower-left corner of the display indicating the display is normalized.

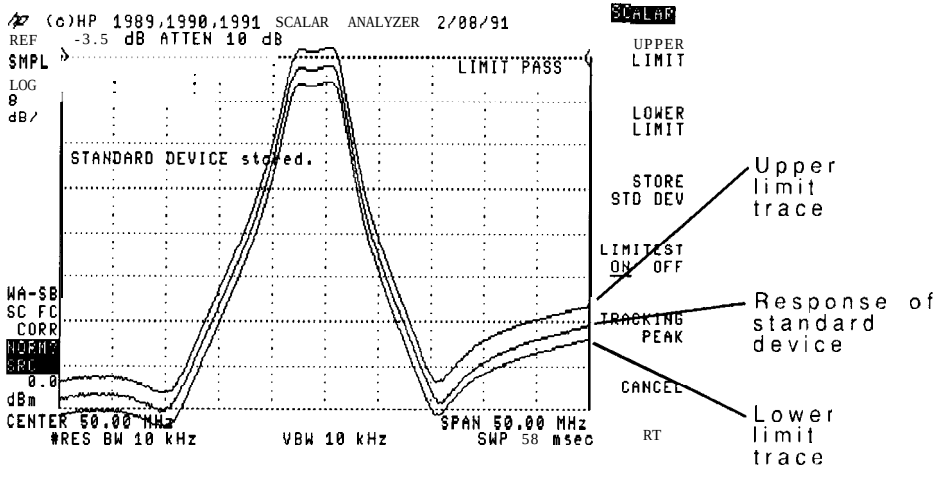
# Calibrating for a standard device

The scalar measurements personality provides a standard device calibration routine. Standard device calibration allows you to make repeated pass/fail testing based on the response of a standard device-under-test. During calibration, instead of using a *through line,* your standard device is placed in the path between the RF output and the RF input connectors. The scalar analyzer personality then creates special limit-line traces above and below the response of the standard device.

The following figure shows the response of a 50 MHz bandpass filter. You could save this response as a standard device against which to test similar bandpass filters.




Limit-line testing is turned on (and upper and lower limit traces displayed) after pressing the CAL key and then the CAL STD DEVICE softkey.




You define the *window* between the upper and lower limit traces using the UPPER LIMIT and LOWER LIMIT softkeys. Enter the amount of deviation in dB between the response of the standard device and the limit trace. The default value is 3 dB.

Standard device calibrations can be performed after a normal open/short or thru calibration. Limit traces created by the standard device calibration *cannot* be edited or stored. To turn off a standard device calibration, press the Calibration menu's LIMITEST ON OFF softkey so that OFF is underlined.

## To calibrate a standard device

1. Connect the device between the front-panel RF OUT and INPUT connectors.

   or

   If you are using the HP 85630A test set, connect the device between the test set's PORT 1 and PORT 2 connectors.

2. Set the scalar analyzer's frequency, span, output power, output attenuation, resolution bandwidth, and reference level for the desired response.
3. Press the front-panel (CAL) key.
4. Press the TRACKIWG PEAK softkey.

   The scalar analyzer performs a short routine to optimize the frequency tracking of the tracking generator.

5. Press the CAL STD DEVICE softkey.
6. Press the UPPER LIMIT softkey, and enter the amount of deviation in dB that is acceptable above the displayed response.
7. Press the LOWER LIMIT softkey, and enter the amount of deviation in dB that is acceptable below the displayed response.
8. Press the STORE STD DEV softkey
9. Replace the standard device with the device to be tested.

# Saving and recalling calibrations

Transmission, reflection, and standard device calibrations can be saved and recalled for later use. (Turning the scalar analyzer off or presetting it will not effect the calibration data.) However, if a calibration is not saved, the calibration data can be lost if one of the following occurs:

- the spectrum analyzer is turned off
- the front-panel [PRESET) key is pressed
- another calibration is performed

## Saving calibrations

When saving calibration data, keep in mind that reflection and transmission calibrations are saved in the same operation as a group of data. Two separate save and recall operations are not needed.

**CAUTION**

Calibration data is saved in trace memory registers. Use caution to avoid deleting any previously saved traces.

Calibrations are saved in CAL groups starting with number 1. Each group requires two trace memory registers and is saved starting at trace register 51. (Trace register 52 is used by the program and is not available.) Trace CAL group 1 corresponds to trace memory registers 50 and 51. As more calibrations are saved, calibration memory grows towards trace memory register 1. If you need to determine availability and use of trace registers, catalog trace memory.

Before being saved, calibration data is temporarily stored in CAL group 0. Unlike the CAL groups used for saving calibrations, this storage area is temporary. Calibration data in CAL group 0 can be lost if it is not saved as described in this section.

**limit lines**

Limit lines, as described in Chapter 5, are also saved in trace memory Limit lines are saved starting at memory register 0 and increasing towards calibration memory As the number of saved calibrations and limit lines grows, the possibility of overwriting limit line or calibration data increases.

## To catalog trace memory

1. Press the [RECALL) key.
2. Press the INTRNL CRD softkey so that INTRNL is underlined.
3. Press the CATALOG INTRNL softkey.
4. Press the CATALOG REGISTER softkey.
5. Use the front-panel knob to scroll the display of trace memory.

## To save calibration data

1. Perform a calibration.
2. Press the More 1 of 2 softkey.
3. Press the SAVE → CAL softkey.
4. Enter a register number.
5. Press [ENTER) to store the calibration data.

## Recalling calibrations

When recalled, calibration data automatically sets the scalar analyzer's frequency, amplitude, and scale parameters appropriate to the calibration. When recalling calibration data, remember the following:

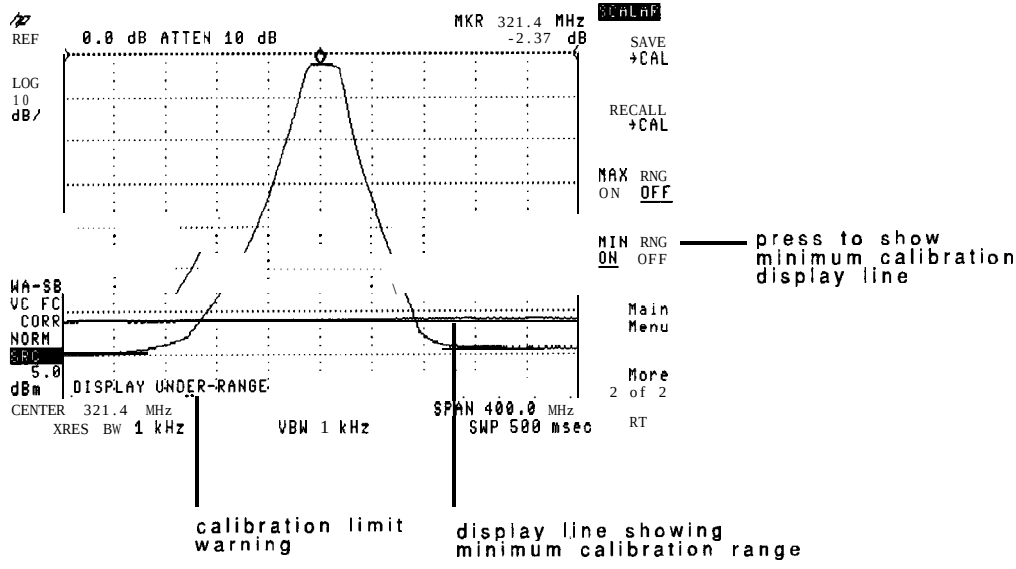
- Normalization remains off until you turn it on.
- Both transmission and reflection calibration data is recalled (if both saved).
- Measurement type (transmission/reflection) is not selected.

## To recall calibration data

1. Press the front-panel [CAL] key.
2. Press the More 1 of 2 softkey.
3. Press the RECALL → CAL softkey.
4. Enter the register number.
5. Press [ENTER] to recall the calibration data.

# Viewing calibration limits

Display calibration has a finite amplitude range. This is due to 70 dB of log fidelity and because normalization shifts the response.




To view the limits of calibration, use the MAX RNG ON OFF and MIN RNG ON OFF softkeys. Horizontal calibration lines are displayed indicating the limits of display calibration. (The lines may not be visible if their amplitude is beyond the displayed scale.) Normally, the calibration lines are turned off.

When a response goes beyond the calibrated limit, the scalar analyzer displays one of the following two messages:

DISPLAYUNDER-RANGE

DISPLAYOVER-RANGE

Portions of the trace displayed outside the calibration limit lines do not show an accurate response. The portion of the response that falls between the two display lines remains calibrated. Portions which cross the displayed line are uncalibrated. Changing the log scale does not affect calibration.

## To view the calibrated limits of the display

1. Press the front-panel (CAL) key.
2. Press the More 1 of 2 softkey.
3. To show the maximum level of calibrated display, press MAX RNG ON OFF so that ON is underlined.
4. To show the minimum level of calibrated display, press MIN RNG ON OFF so that ON is underlined.

# Changing the normalized position and reference level

The default normalized reference position is at the display's top graticule line. (It is represented on screen by an angle bracket at each end of a horizontal graticule line.) NORM REF POSN sets the reference position to any of the eight major horizontal graticule lines. Position eight is the top graticule; position zero is the bottom graticule.

The reference position is always the top graticule line when normalization is turned off.

The scalar analyzer places the normalized reference level at the normalized reference position. (The default is at top horizontal line of the graticule.)

## To change the normalized reference position

1. Press the front-panel (AMPLITUDE) key.
2. Press the NORM REF POSN softkey.
3. Use the front-panel knob or numeric keypad to place the normalized reference position at any of the eight major horizontal graticules.

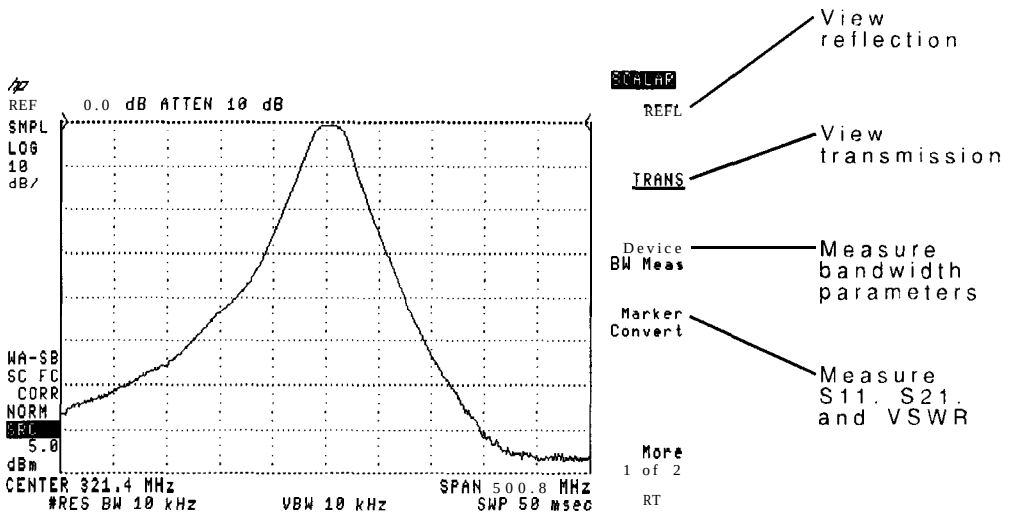
4

# Measuring Reflection/Transmission Parameters

# Measuring Reflection/Transmission Parameters

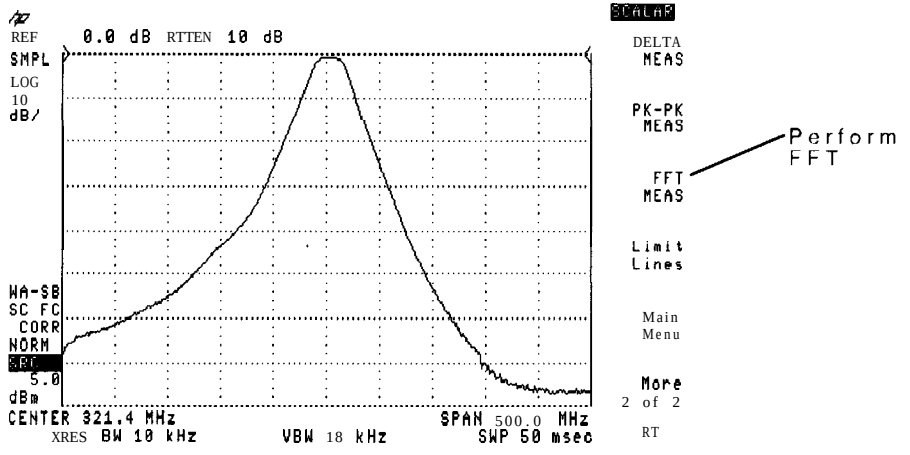
The HP 85714A scalar measurements personality not only displays device reflection and transmission, but in addition provides automatic measurements for device characterization. These include VSWR, transmission/reflection coefficients, bandwidth, and shape factor parameters. This chapter includes information on swept-power measurements which allow you to characterize distortion related to input power.

To enter the Measure menu, press the front-panel (MEAS/USER) key or press the Main menu's Measure softkey.




**Page One of Measure Menu**

For information on using the DELTA **MEAS** , PK-PK **MEAS** , and Limit Lines softkeys, refer to Chapter 5.

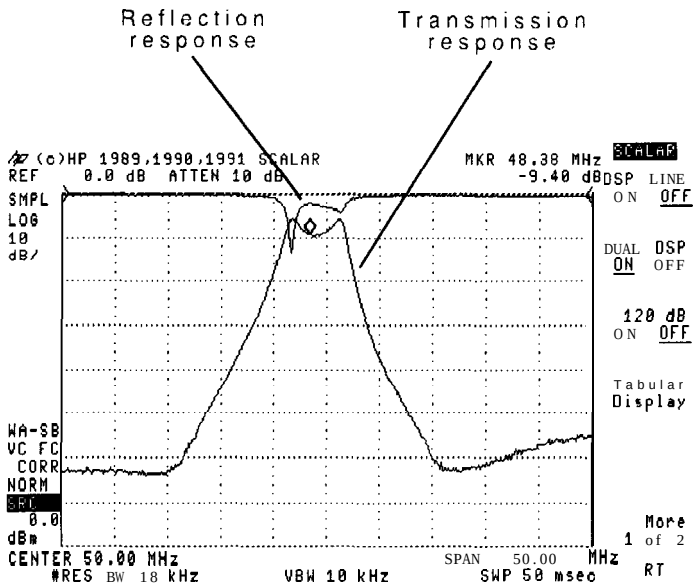



**Page Two of Measure Menu**

# Viewing transmission and reflection

After normalizing the display, the scalar measurements personality offers extensive control for viewing the response on the screen.

If an HP 85630A scalar transmission/reflection test set is used, you can easily switch between transmission and reflection measurements. The test set also provides the ability to simultaneously display both responses. The scalar analyzer automatically controls the HP 85630A scalar transmission/reflection test set for the two measurement setups.

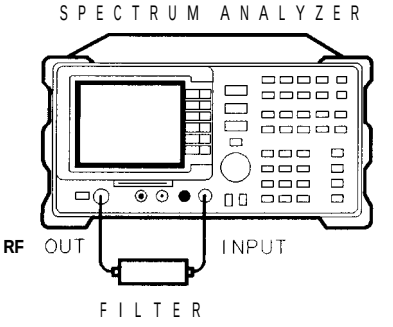



NOTE

If you don't have the test set, you must manually use external cabling and couplers to view reflection.

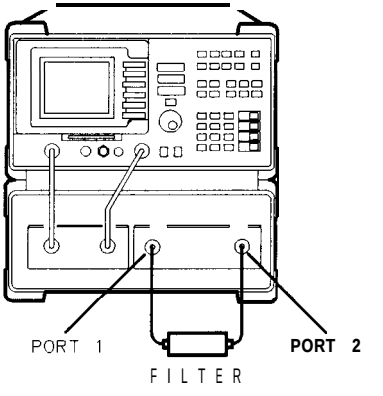
# To view device transmission

1. Calibrate the measurement as explained in "To Calibrate a Transmission Measurement" in this chapter.
2. If you are *not* using the HP 85630A test set, connect the device being measured (for example a filter) between the scalar analyzer's RF OUT and INPUT connectors.




PV28

3. If you are using the HP 85630A test set, connect the device being measured between the PORT 1 and PORT 2 connectors.



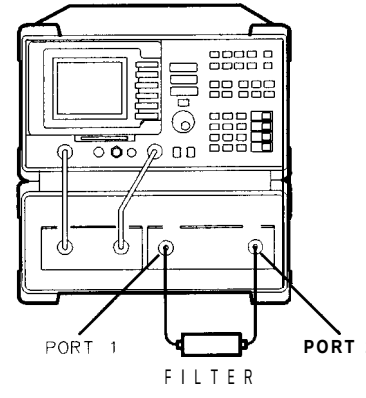

PV220

4. Press the (MEAS/USER) key.
5. Press the TRAWS softkey so that it is underlined.

## To view device reflection

You must use an external bridge (test set) to view device reflection. The optional HP 85630A scalar transmission/reflection test set is the recommended test set.

1. Calibrate the measurement as explained in "To Calibrate a Reflection Measurement" in Chapter 3.
2. Connect the device being measured (for example a filter) between the PORT 1 and PORT 2 connectors of the HP 85630A test set.



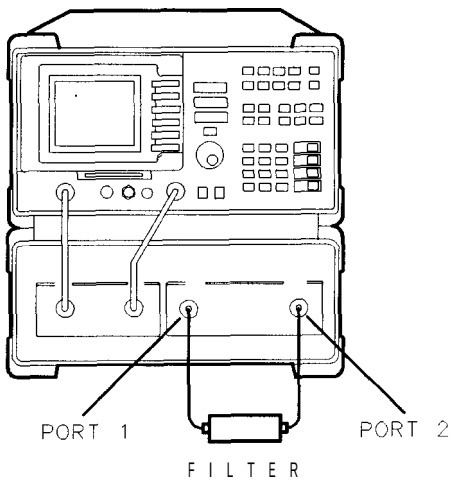

PV220

3. Press the (MEAS/USER) key.
4. Press the **REFL** softkey so that it is underlined.

## To view transmission/reflection simultaneously

Viewing both the transmission and reflection response simultaneously requires an HP 85630A scalar transmission/reflection test set.

1. Make sure the HP 85630A scalar transmission/reflection test set is turned on as described in Chapter 2.
2. Calibrate the measurement as explained in "To calibrate a Transmission measurement" and "To calibrate a reflection measurement" in Chapter 3.
3. Connect the device being measured (for example a filter) between the PORT 1 and PORT 2 connectors of the HP 85630A test set.




PV220

4. Press the DISPLAY key.
5. Press the DUAL DSP ON OFF softkey so that ON is underlined.

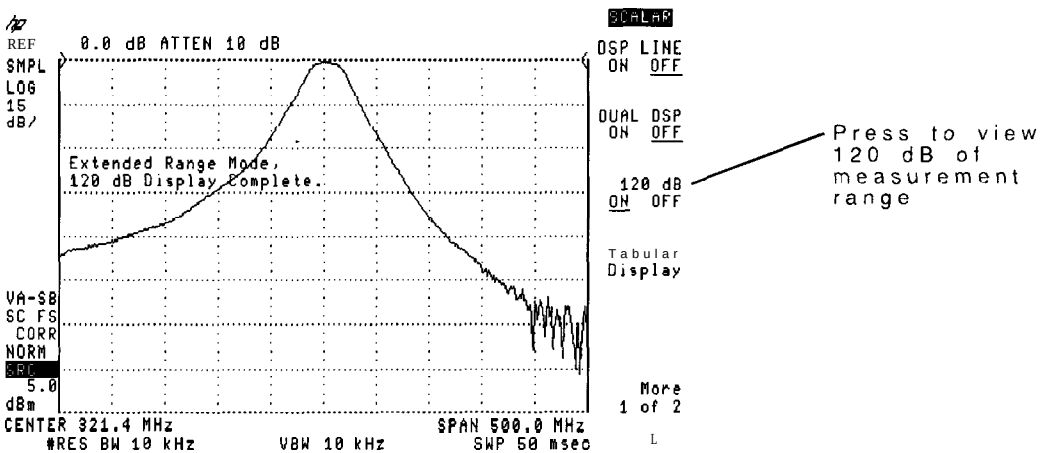
## To turn normalization off

1. Press the front-panel (CAL) key.
2. Press the NORMLIZE ON OFF softkey so that OFF is underlined.

Use this feature to temporarily turn normalization on or off.

# Viewing 120 dB of measurement range

The scalar analyzer can display a 120 dB measurement range not available with the normal 15 dB per division log scale.




The 120 dB calibrated measurement range is achieved by splicing two separate traces. For each visible sweep, the scalar analyzer first saves the top 50 dB of trace data. Then, the reference level is set up to 50 dB below the current reference level and another reading is taken. Finally, these two traces are spliced together and displayed on the screen.

To achieve greater than 85 dB of dynamic range, perform the measurement without the HP 85630A Scalar Transmission/Reflection Test Set.

**In dual display mode**

You cannot view 120 dB measurement range in the dual display mode. (Dual display refers to simultaneously displaying both transmission and reflection responses.)

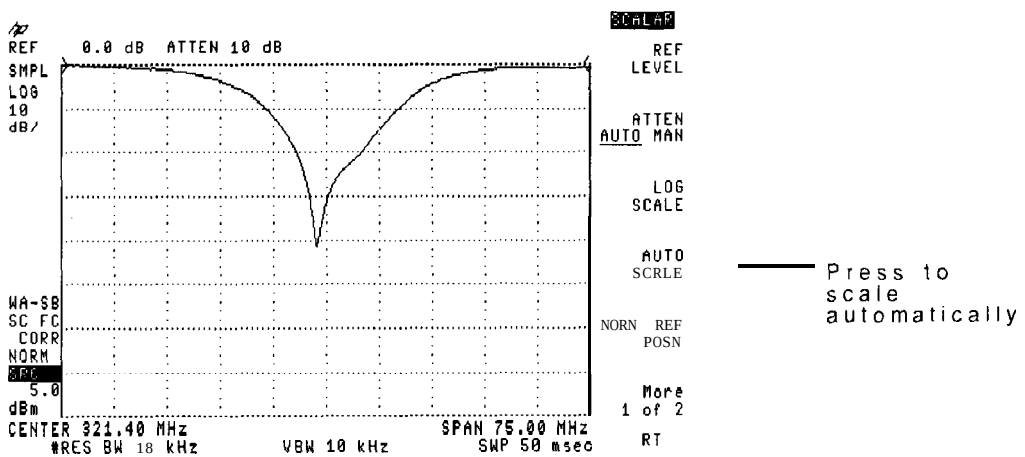
Use the 120 dB ON OFF softkey to turn on the 120 dB measurement range feature. This feature places the spectrum analyzer in single sweep mode. Press the (SGL SWP) key to remeasure a device.

## To view 120 dB of measurement range

1. Press the front-panel (DISPLAY) key.
2. Press the 120 dB ON OFF softkey so that ON is underlined.
3. Press the (HOLD) key to remove the displayed measurement message
4. Press the (SGL SWP) key each time you need an updated display.

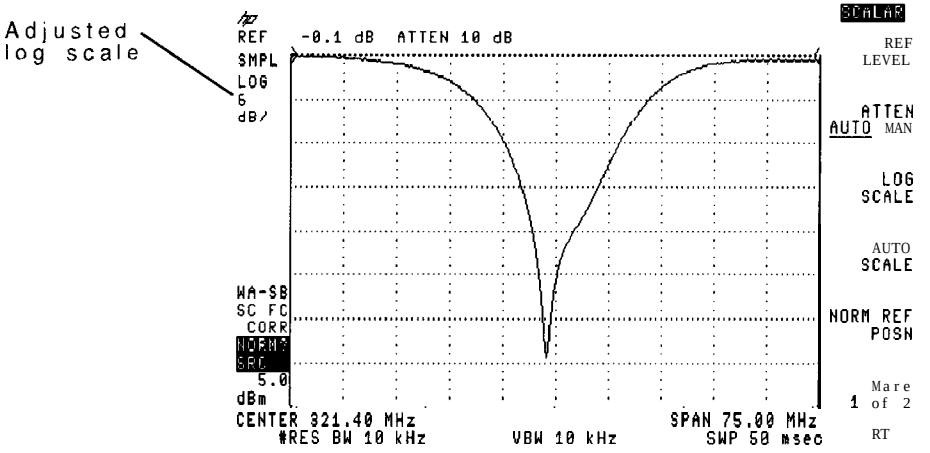
# Automatically scaling the response

The scalar analyzer provides one-button scaling. To scale the response for full screen, simply press the Amplitude menu's AUTO SCALE softkey. Of course, you can still manually scale the response by changing the normalized reference level and log scale.




**Response before Automatic Scaling**

Auto scaling is a one-time adjustment. The log scale does not continually update when the response amplitude changes.

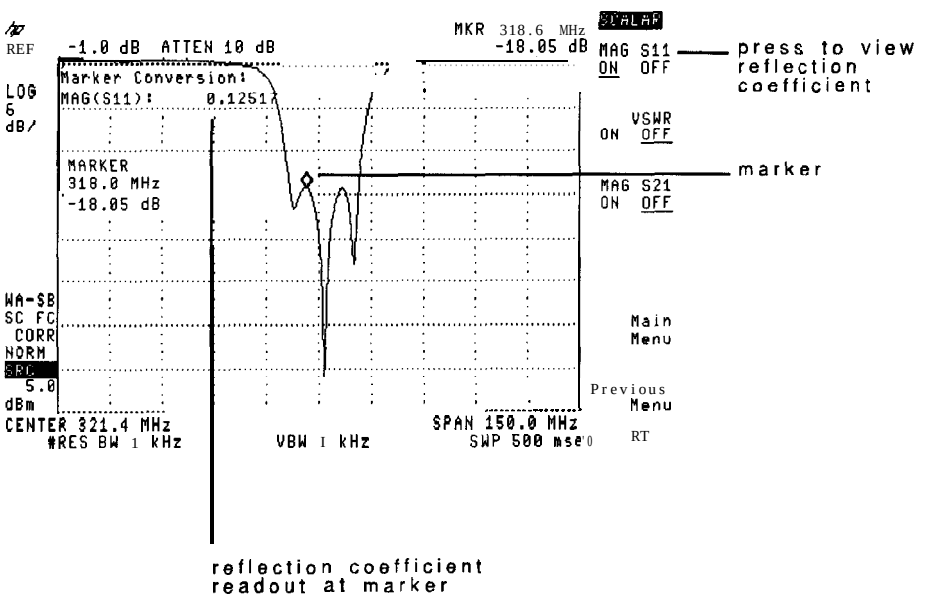



**Response after Automatic Scaling**

## To automatically scale the response

1. Press the front-panel (AMPLITUDE) key.
2. Press the AUTO SCALE softkey.

The scalar measurements personality can display the VSWR, transmission coefficient ($S_{21}$), or reflection coefficient ($S_{11}$) at any point along the displayed response. (VSWR and reflection coefficient measurements require the use of the HP 85630A scalar transmission/reflection test set.)




The scalar measurements personality displays a moveable marker showing the value at the marker position. The displayed values are continuously updated. This is true even in single sweep and view modes. Softkeys for these measurements are available from the Measure menu's Marker Convert selection.

## To measure transmission coefficient

1. Display the desired response on the scalar analyzer's display.
2. Press the (MEAS/USER) key and then the Marker Convert softkey.
3. Press the NAG S21 ON OFF softkey so that ON is underlined.
4. Move the marker to the desired trace position, and read the displayed transmission coefficient.

## To measure reflection coefficient

1. Display the desired response on the scalar analyzer's display.
2. Press the (MEAS/USER) key and then the Marker Convert softkey.
3. Press the MAG S11 ON OFF softkey so that ON is underlined.
4. Move the marker to the desired trace position, and read the displayed reflection coefficient.

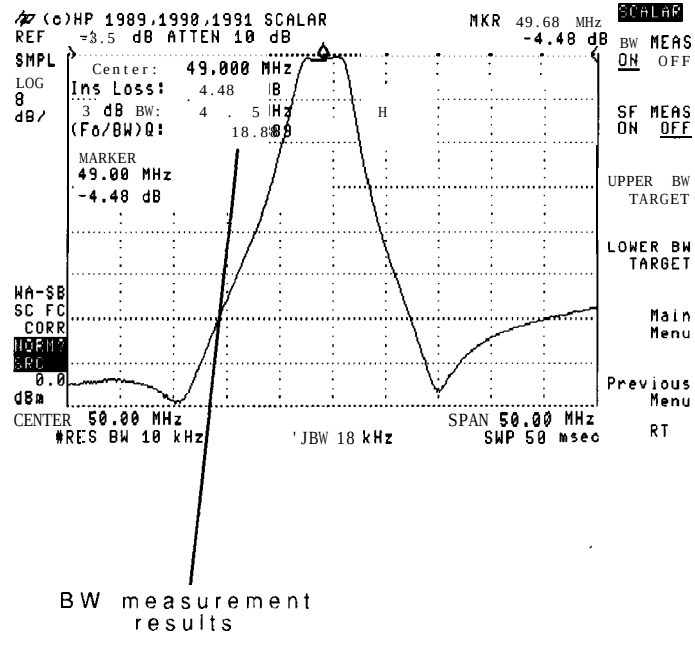
## To measure VSWR

1. Display the desired response on the scalar analyzer's display.
2. Press the (MEAS/USER) key and then the Marker Convert softkey.
3. Press the VSWR ON OFF softkey so that ON is underlined.
4. Move the marker to the desired trace position, and read the displayed voltage standing wave ratio.

# Measuring insertion loss and bandwidth parameters

The scalar analyzer performs the following bandwidth measurements:

- center frequency
- insertion loss in dB
- bandwidth
- Q




Bandwidth measurements are updated after each sweep. The bandwidth measurement uses a 3 dB default bandwidth (upper bandwidth). The default bandwidth used can be changed using the UPPER BW TARGET softkey. For example, you could change the bandwidth from 3 dB to 6 dB. Lower bandwidth is not defined for this measurement.

The Q indicates the frequency selectivity of a response. The narrower the bandwidth at a given frequency, the higher the Q. It is defined by the following formula:

$$Q = \frac{f_o}{BW}$$

where:

$f_o$ is the center frequency of the displayed response

BW is the bandwidth of the displayed response.

## To measure insertion loss and bandwidth parameters

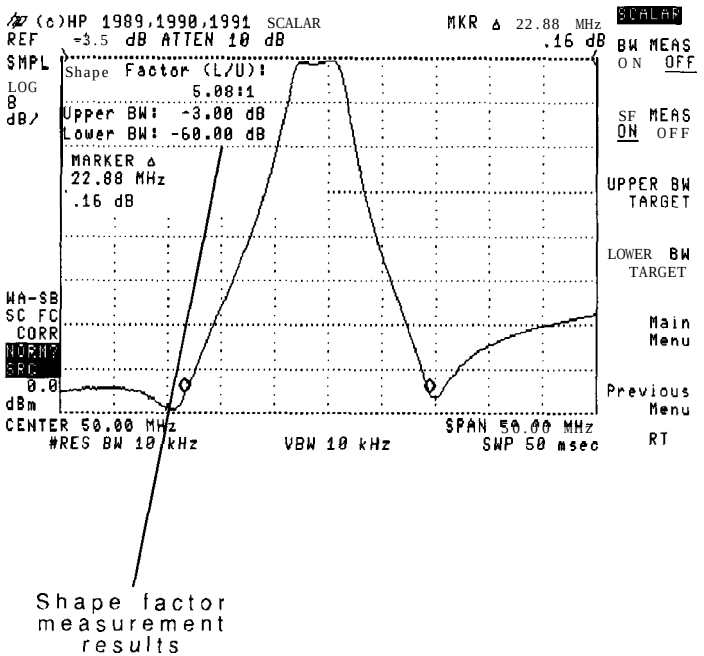
1. Display the desired response on the scalar analyzer's display.
2. Press the (MEAS/USER) key and then the Device **BW Meas** softkey.
3. Press the **BW MEAS** ON OFF softkey so that ON is underlined.

   The measurement continually repeats until the BW **MEAS** ON OFF softkey is pressed so that OFF is underlined.

The response's center frequency, insertion loss, bandwidth, and Q is displayed on the screen.

# Measuring filter shape factor

Shape factor characterizes the slope of a bandpass filter's skirts.




Shape factor is the ratio of upper and lower bandwidths of the response. The larger the shape factor, the less selective the filter.

$$shape\ factor = \frac{lower\ response\ bandwidth}{upper\ response\ bandwidth}$$

The default bandwidths used are:

| | |
|---|---|
| upper bandwidth . . . . . | 3 dB |
| lower bandwidth . . . . . | 60 dB |

Default bandwidths for shape factor measurements can be changed using the UPPER BW TARGET and LOWER BW TARGET softkeys. For example, using

the UPPER BW TARGET softkey, you could change the upper bandwidth from 3 dB to 6 dB.

Shape factor measurements are updated after each sweep.

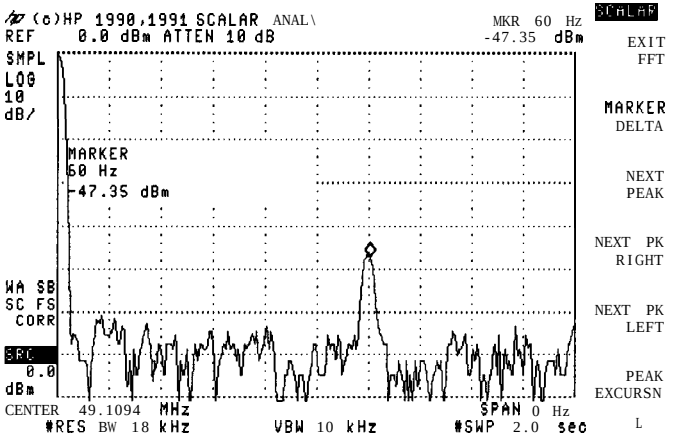
## To measure shape factor

1. Display the desired response on the scalar analyzer's display.
2. Press the (MEAS/USER) key and then the Device BW **Meas** softkey.
3. Press the SF **MEAS** ON OFF softkey so that ON is underlined.

   The measurement continually repeats until the SF **MEAS** ON OFF softkey is pressed so that OFF is underlined.

# Performing fast fourier transforms

Fast fourier transforms (FFTs) convert zero-span data into the frequency domain. Use FFTs to observe signal distortion caused by a device. During an FFT, the scalar analyzer is in single sweep with a 10 dB/division log amplitude scale.




Performing an FFT turns on the marker for locating signal peaks on the FFT.

The FFT's frequency span is related to the sweep time. (The slower the sweep time, the narrower the span.) Set the sweep time according to the following formula:

$$sweep\ time = \frac{200}{frequency\ span}$$

# To perform fast fourier transforms

1. Press the front-panel [FREQUENCY] key, and enter the frequency at which to perform the FFT.
2. Press the front-panel (SPAN) key and enter 0 Hz.
3. Press the front-panel (SWEEP) key.
4. Enter the sweep time required to achieve the desired FFT frequency span.

$$sweep\ time = \frac{200}{frequency\ span}$$

5. Press the (MEAS/USER) key and then the More 1 of 2 softkey.
6. Press the FFT **MEAS** softkey to display the FFT.
7. To exit from the FFT display, press the EXIT FFT softkey

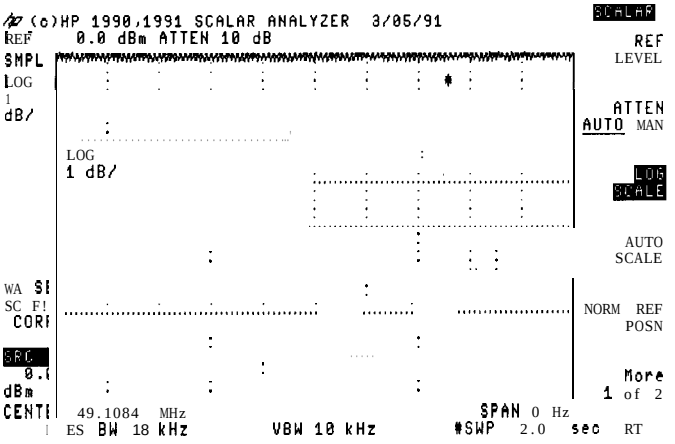
## Example: Measuring 60 Hz hum from an amplifier

One measure of an amplifier's performance is 60 Hz hum. This measures the amount of 60 Hz amplitude-modulation distortion placed on the amplified signal.

1. Connect the amplifier between the scalar analyzer's front-panel RF OUT and INPUT connectors.

**CAUTION** Make sure the input power level is not above the spectrum analyzer's maximum input value.

2. Press the front-panel (FREQUENCY) key, and enter the frequency at which to perform the FFT.
3. Press the front-panel [SPAN) key and enter 0 Hz. In the following figure, the amplitude modulation can be seen on the amplified signal.



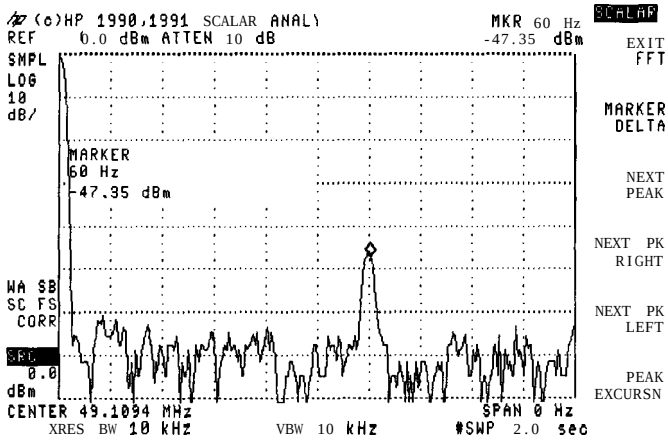

**Zero-span response before FFT**

4. Press the front-panel (SWEEP) key.
5. Enter a sweep time of 2.0 seconds.

   A 2.0 second sweep time gives an FFT frequency span of 100 Hz

6. Press the (MEAS/USER) key and then the More 1 of 2 softkey.

7. Press the FFT MEAS softkey to display the FFT.




**FFT showing 60 Hz amplitude modulation**

8. Press the MARKER DELTA softkey.

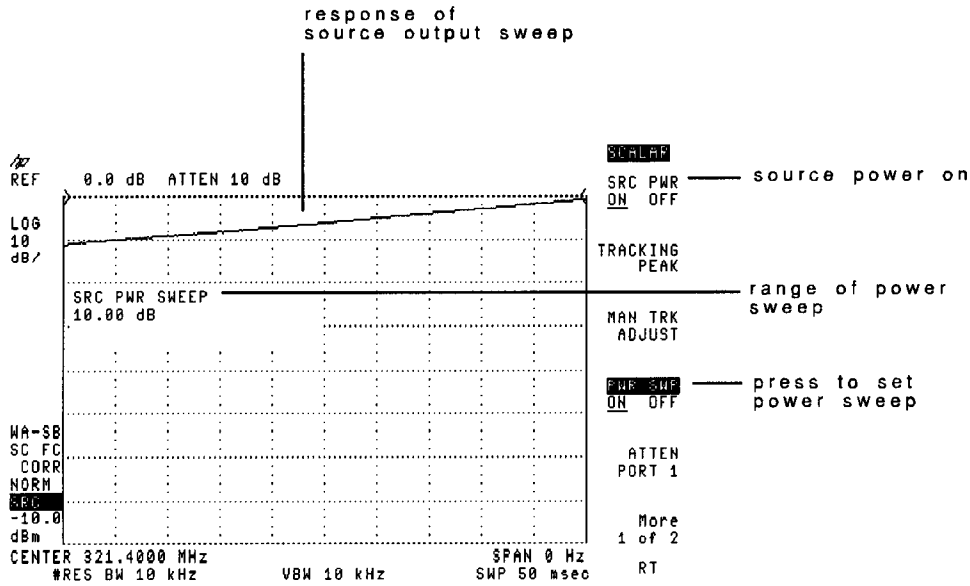
9. Use the front-panel knob to scroll the marker to the 60 Hz peak.

10. Read the marker value, and determine the percent of amplitude modulation by substituting the value as dBc in the following formula. (Notice the minus sign indicating dBc is a negative value.)

$$Percent\ AM = (200)\ 10^{\left(\frac{-dBc}{20}\right)}$$

For example, if 60 dB separates the 60 Hz modulation from the carrier, the percent of amplitude modulation is 0.2 %

With the scalar measurements personality, you can sweep the input power to a device in both zero span and with frequency sweeps. This enables the characterization of a device with respect to input power. Power sweeps can be used to measure the compression of devices such as amplifiers and limiters. Power sweeps can also be used to compensate for frequency-related losses. For example, losses from a test setup cable.



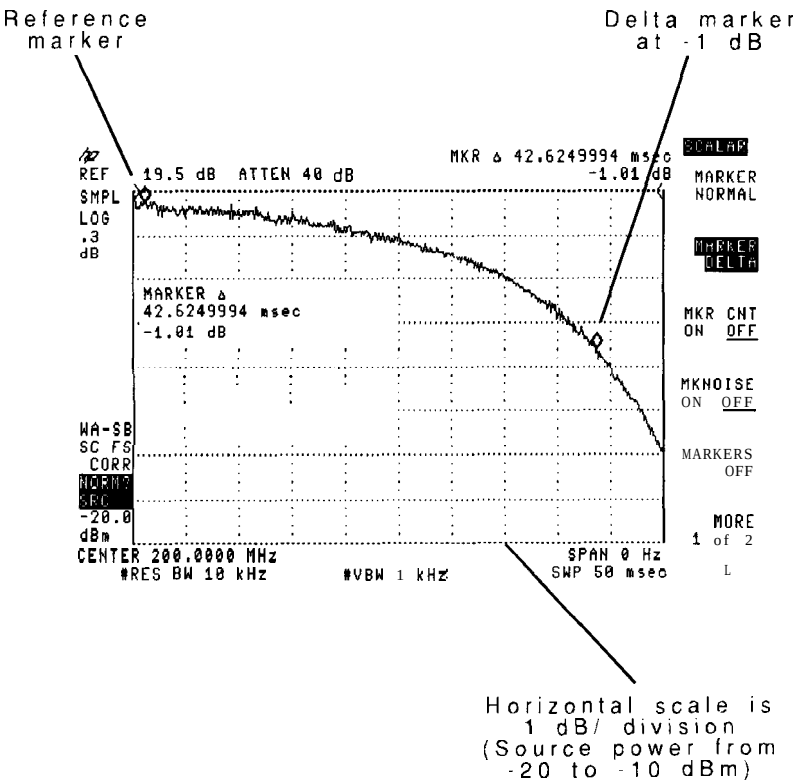

The normalizing capability of the scalar measurements personality enables viewing of the response compression.

## To perform swept-power measurements

1. Connect the source's output to the scalar analyzer's input.
2. Set the scalar analyzer to the desired center frequency. Set the spanwidth to 0 Hz.
3. Press the (AUX CTRL) key, then enter the source's power.

   This is the sweep's start power.
4. Press the **PWR SWP ON** OFF softkey twice so that ON is underlined.
5. Enter the amount of power change in dB of the power sweep. (Press the (ENTER) key to complete the entry.)
6. Set the reference level so that when the device to be tested is inserted in the line, any gain will not cause the response to be off screen.
7. Press the (CAL) key, CAL **THRU** , and STORE THRU softkeys.
8. Place the device to be tested between the source's output and the scalar analyzer's input.
9. Press the (AMPLITUDE) key, and then set the normalized reference level so that the response is displayed.
10. Press the AUTO SCALE softkey.

# Example: measuring amplifier compression




This example measures the 1 dB compression point of an HP 8447A Dual Amplifier. The measurement requires placing the scalar analyzer in a zero frequency span and sweeping the input power to the amplifier.

The HP 8447A Dual Amplifier has 20 dB of gain 100 kHz to 400 MHz. We'll locate its 1 dB compression point at 200 MHz. Because the amplifier's output compression point is typically greater than 6 dBm, we need to sweep its output power from 0 to + 10 dBm. The amplifier's 20 dB of gain requires

that we sweep its input power from -20 to -10 dBm to meet our output requirements.

The example does *not* use the HP 85630A scalar transmission/reflection test set. If you use the test set, you'll need to compensate for the power loss of the test set.

**CAUTION** Be sure that the spectrum analyzer's input power does not exceed +30 dBm or damage will result.

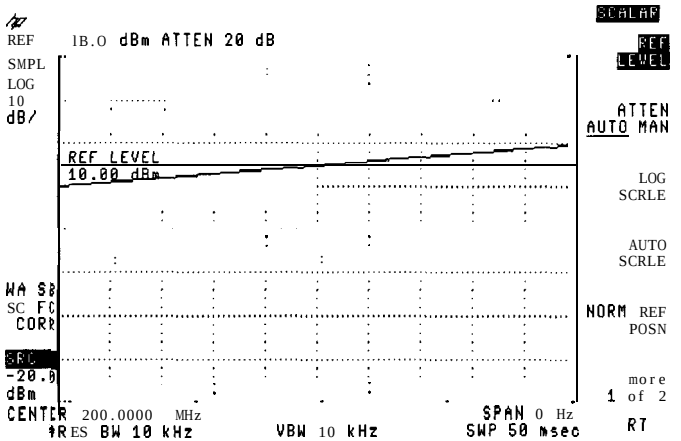
1. Press the PRESET SCALAR softkey in the scalar analyzer's Main menu.
2. Use a BNC cable to connect the scalar analyzer's RF OUT and INPUT connectors.
3. Press the [FREQUENCY] key and enter a center frequency of 200 MHz.
4. Press the (SPAN) key and enter a frequency span of 0 Hz.

   The scalar analyzer is now a fixed-tuned receiver at 200 MHz.
5. Press the (AUX CTRL) key.
6. Press the TRACKING PEAK softkey.
7. Enter a source power level of -20 dBm.

   This sets the starting power level for the power sweep.
8. Press the PWR SWP ON OFF softkey twice so that ON is underlined.
9. Enter 10 dB.

   This sets the amount of the power sweep. The scalar analyzer is now sweeping the source's output power from -20 to -10 dBm.
10. Press the [AMPLITUDE] key and enter a reference level of 10 dBm.

    This step places the stop power level 20 dB below the displayed reference level. This is necessary to ensure a calibrated display with the amplifier's 20 dB of gain.




11. Press the (CAL) key followed by the CAL THRU softkey.

12. Press the STORE TWRU softkey.

    The scalar analyzer's display is now normalized for the power sweep.

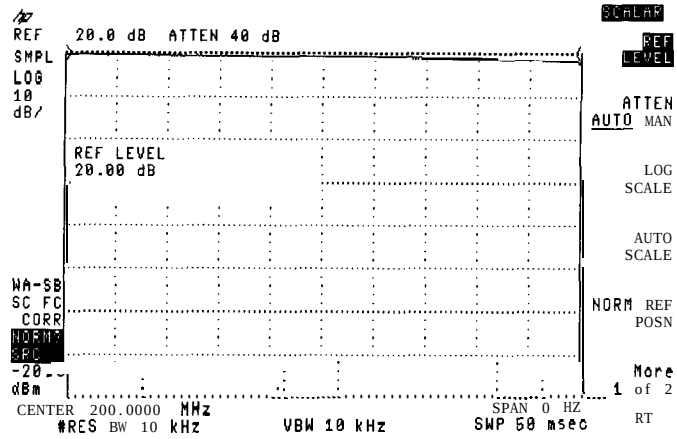
13. Connect the scalar analyzer's RF OUT to the amplifier's INPUT connector,

14. Connect the amplifier's OUTPUT connector to the scalar analyzer's INPUT connector.

15. Press the (AMPLITUDE) key.

16. Press the REF LEVEL softkey. Enter a reference level of 20 dB.

    This places the amplifier's response on the screen. However, changing the reference level introduces error caused by reference level accuracy. This is indicated on screen by the ? character displayed after the NORM annotation.




17. Press the AUTO SCALE softkey.

    The AUTO SCALE function reduces the scalar analyzer's log scale as necessary to fill the complete display with the response.

18. Press the (BW) key. Press the VID BW AUTO MAN softkey twice so that MAN is underlined.

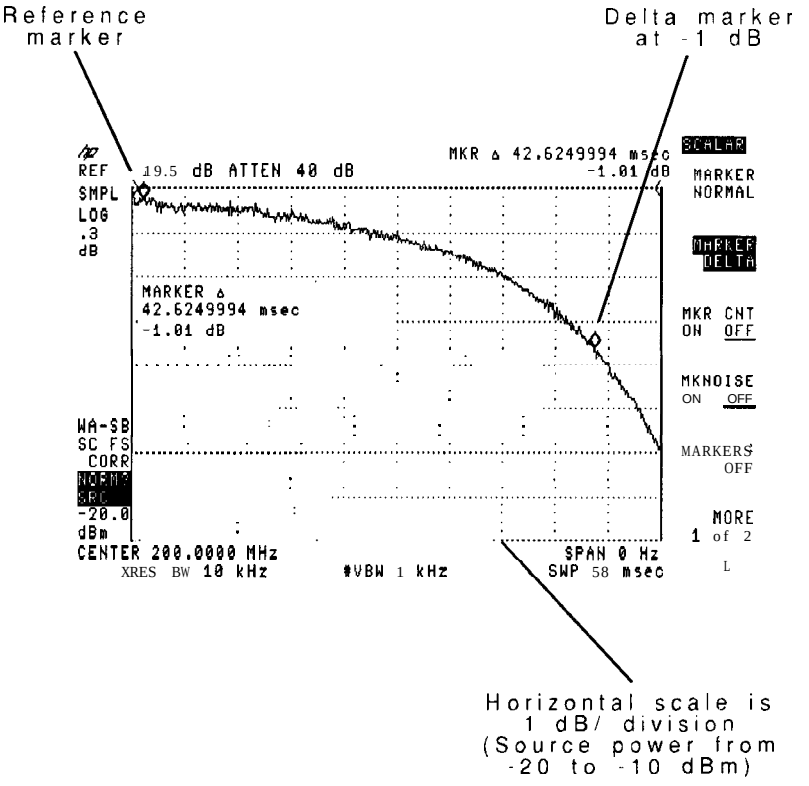
19. Reduce the video bandwidth to 1 kHz

    Do *not* change the resolution bandwidth or additional measurement uncertainties will be introduced. Reducing the video bandwidth reduces the noise displayed on the trace.

20. Press the (SGL SWP) key to stop the trace.

21. Press the (MKR) key, and use the front-panel knob to place the marker at the peak of the response.

22. Press the MARKER DELTA softkey and move the delta marker on the response so that it reads -1 dB. This is the 1 dB compression point of the amplifier at 200 MHz.




23. Press the MARKER NORMAL softkey.

    The marker readout now indicates the device gain at the 1 dB compression point. In this case 18.4 dB. See the Egure at the end of this procedure.

24. Based on the horizontal power scale of 1 dB per division, calculate the input power level at the 1 dB compression point.

$$P_{input} = start\ power + \left(\frac{power\ sweep\ range}{10\ horz.\ divisions}\right)(number\ of\ divisions)$$

$$P_{input} = -20\ dBm + \left(\frac{10\ dB}{10\ div.}\right)(9.8\ div.)$$

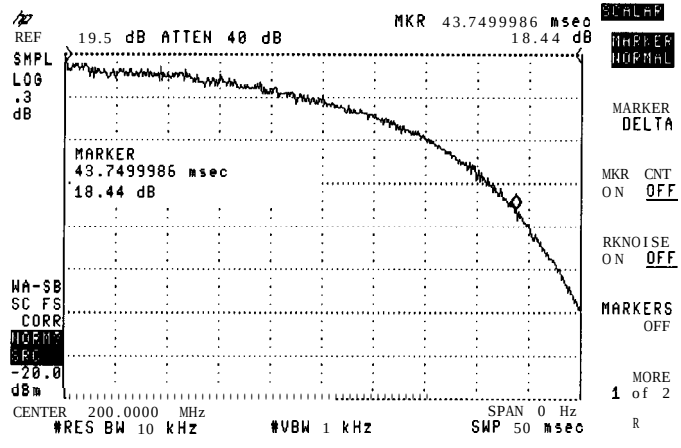
$$P_{input} = -10.2\ dBm$$

25. To calculate the output power at the 1 dB compression point, add the input power level determined in the previous step to the gain at the compression point (marker value).

$$P_{output} = P_{input} + compressed\ gain$$

$$P_{output} = \mathbf{-10.2}\ dBm + \mathbf{18.4}\ dB$$

$$P_{output} = 8.2\ dBm$$



5

# Using Markers and Limit Lines

# Using Markers and Limit Lines

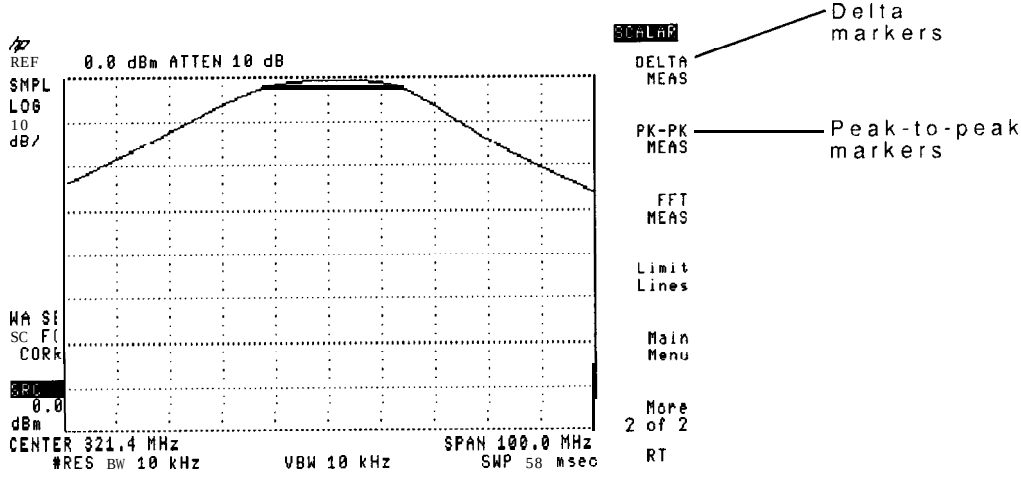
Peak-to-peak markers and delta markers enable you to quickly measure absolute and relative amplitude and frequencies of a response. Limit lines enable you to perform repeatable production-line testing.

**Multiple Markers and Marker Tables**

Multiple markers, which are available with the HP 8591E, HP 8593E, HP 8594E, HP 8595E, and HP 8596E, are not available when in Dual Display Mode.

The MK TABLE function is not available when in the Scalar personality mode.

Enter the second page of the Measure menu to use markers. (Press the front-panel MEAS/USER key, or press the Main menu's Measure softkey.)




**Second Page of Measure Menu**

After selecting DELTA **MEAS** or PK-PK **MEAS** , use the NEXT PEAK , NEXT PK RIGHT , and NEXT PK LEFT softkeys to place the displayed marker on a signal peak. Marker frequency and amplitude are directly read from the display. The MARKER DELTA softkey displays the relative amplitude and frequency between two displayed markers.

When searching for a signal peak, the scalar analyzer recognizes signals that rise and fall by a predefined excursion value. This default excursion value is 6 dB. You can change the excursion value by using the PEAK EXCURSN softkey.

## To use peak and delta markers

1. Display the desired response on the scalar analyzer's display.
2. Press the (MEAS/USER) key and then the More 1 of 2 softkey.
3. Press the PK-PK **MEAS** softkey to perform peak marker measurements.
4. Press the DELTA **MEAS** softkey to perform relative marker measurements.
5. Press the EXIT PK-PK or EXIT DELTA softkeys to turn the markers off and return to the Measure menu.

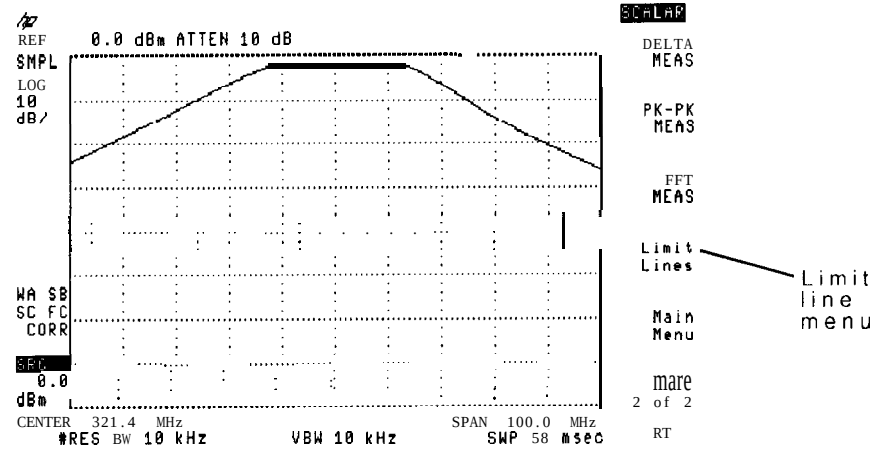
## To define what is a valid peak

1. Press the (MEAS/USER) key and then the More 1 of 2 softkey.
2. Press either the PK-PK **MEAS** or DELTA **MEAS** softkeys.
3. Press the PEAK EXCURSN softkey, enter the value in dB that represents the smallest acceptable peak excursion.

# Creating limit lines

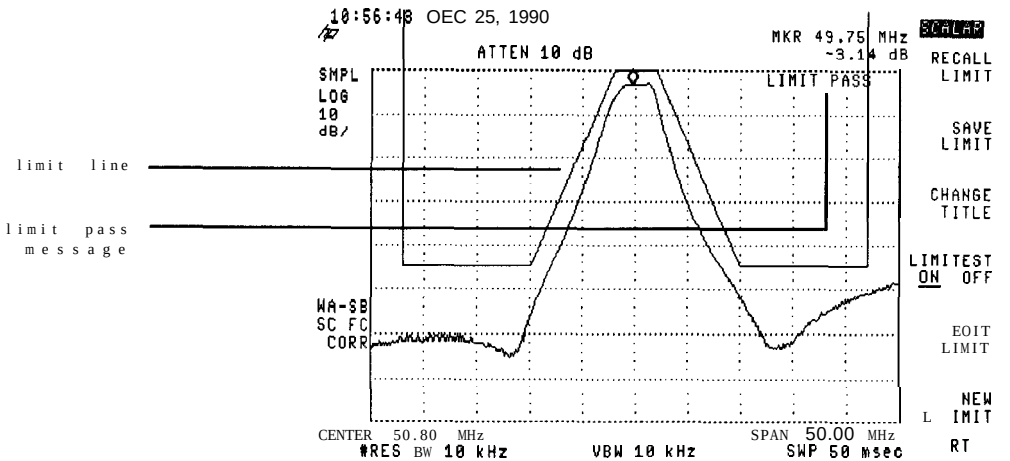
Limit lines are displayed lines showing acceptable limits for a displayed response. In production settings, limit lines can be used for pass/fail testing. Enter the second page of the Measure menu to use limit lines. (Press the front-panel (MEAS/USER) key, or press the Main menu's Measure softkey.)

You define the shape (including upper and lower limits) of the limit lines. If the response is outside the limit lines, a failure message is displayed.

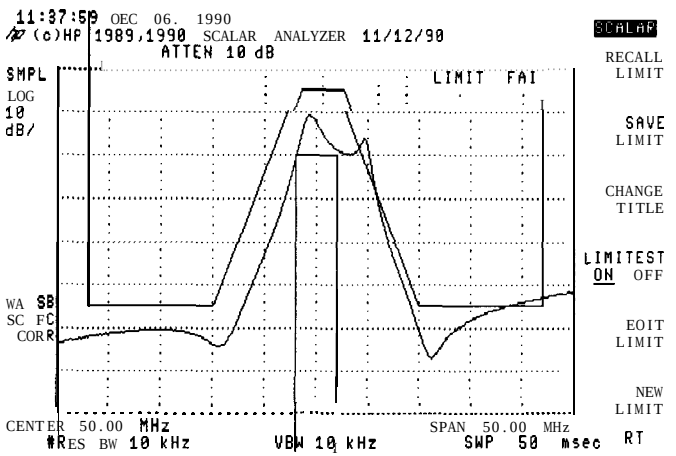



**Second Page of Measure Menu**

You define the shape (including upper and lower limits) of the limit lines. If the response is outside the limit lines, a failure message is displayed as shown in the following figures.




**limit line with LIMIT PASS message**




**limit line with LIMIT FAIL message**

You can create limit lines that:

1. Define the upper limit of a response.
2. Define the lower limit of a response.
3. Define both lower and upper response limits.
4. Display relative to the center frequency and reference level.
5. Display at a fixed center frequency and reference level.

You create limit lines that are either fixed or relative with respect to the scalar analyzer's frequency and reference level. After being displayed, relative limit lines do not change screen position if the frequency or reference level is changed. However, fixed limit lines do change screen position if the frequency or reference level is changed.

The two tutorials, located at the end of this, chapter give step-by-step instructions for creating limit lines. Be prepared to spend about twenty minutes on the tutorials. Both tutorials draw the same limit lines using two alternate methods.

**limit-line amplitude units**

After display normalization, the amplitude units displayed for limit lines and entered using the front panel are in dBm (decibels relative to 1 mW). However, because of display normalization, the units actually used are decibels (dB). The power levels are relative to the normalized reference level.

**limit lines and the normalized reference position**

When editing or creating limit lines (the EDIT LIMIT or NEW LIMIT softkey is pressed), the scalar measurements personality sets the normalized reference position to eight. This is the default normalized reference position at the top of the screen. The original position is restored when the EDIT DONE softkey is pressed.

## To enter the limit line menu

1. Press the (MEAS/USER) key.
2. Press the More 1 of 2 softkey.
3. Press the Limit; Lines softkey.

## To make a limit-line relative or fixed

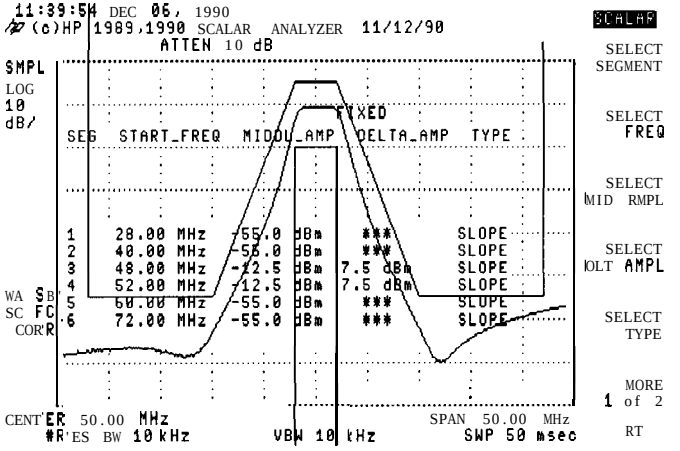
1. With a limit line displayed on the screen, press the (MEAS/USER) key.
2. Press the More 1 of 2 softkey.
3. Press the Limit Lines softkey followed by the EDIT LIMIT softkey.
4. Press the LIMITS FIX REL softkey so that desired selection is underlined.

## Limit-line segments

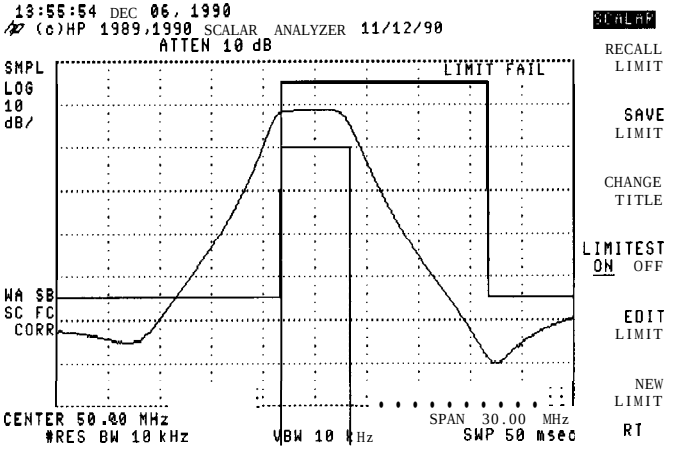
Limit lines are made by "drawing" lines between frequency/amplitude points. Each line is called a segment. Segments begin at a starting frequency and continue to the next segment.

Segments can be one of three types: SLOPE, FLAT, or POINT. With slope types, segments with different amplitudes are connected using sloping lines. With Flat types, segments remain constant in amplitude until the next segment's starting frequency is reached. With point types, a segment's starting frequency is not connected to the next segment.

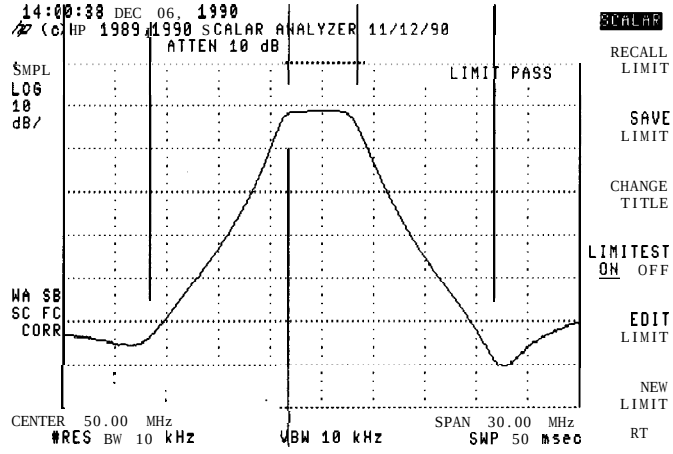
The following figures illustrate the difference between the three slope types. The limit lines in each figure are identical except for the segment's type.




**SLOPE Segment Types**




**FLAT Segment Types**




**POINT Segment Types**

## To enter or edit a limit-line's title

1. If you are creating or editing a limit line, press the EDIT DONE softkey after all data has been entered.
2. In the Limit Line menu, press the CHANGE TITLE softkey.
3. Use the front-panel softkeys to select the desired characters.

   You can also press the MORE 1 af 2 then RPG TITLE softkeys and use the front-panel knob to select the desired characters.
4. Press the front-panel (BK SP) key to backspace over a character.
5. To erase a title, press the YX_# SPC CLEAR softkey and then the CLEAR softkey.

## To turn limit testing on

In order to turn limit testing on, you must first create a limit line.

1. Create a limit line.
2. Press the limit-line menu's LIMITEST ON OFF softkey so that ON is underlined.

# Saving and recalling limit lines

Limit lines can be saved and recalled for later use. (Presetting or turning the scalar measurements personality off will not effect the limit line data.)

**CAUTION**

Limit line data is saved in trace memory registers. Use caution to avoid deleting any previously saved traces.

Each limit line requires one trace memory register and is saved starting at trace register 0. Limit line 0 corresponds to trace memory registers 0. As more limit lines are saved, limit line memory grows towards trace memory register 5 1.

Catalog trace memory if you need to determine availability and use of trace registers.

**Calibration data**

Calibrations are also saved in trace memory starting at memory register 51 and growing towards register 0. As the number of saved calibrations and limit lines grows, the possibility of overwriting memory increases.

## To catalog trace memory

1. Press the (RECALL) key.
2. Press the INTRNL CRD softkey so that INTRNL is underlined.
3. Press the CATALOG INTRNL softkey.
4. Press the CATALOG REGISTER softkey.
5. Use the front-panel knob to scroll the display of trace memory.

## To save a limit line

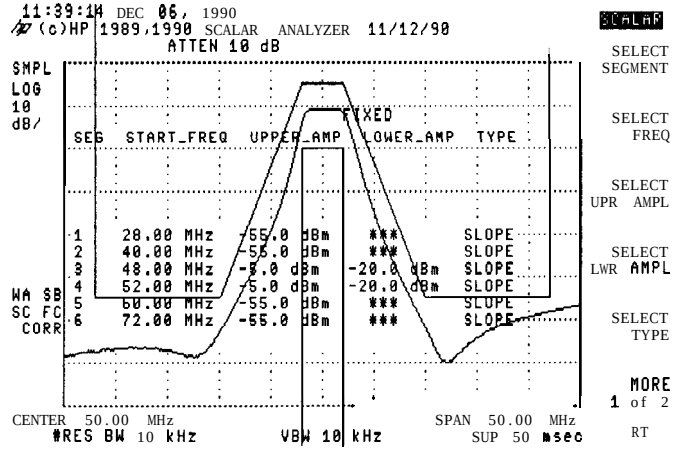
1. Create a limit line.
2. Press the limit-line menu's SAVE LIMIT softkey.
3. Press a number representing a memory register.
4. Press the (ENTER) key.

## To recall a limit line

1. Press the limit-line menu's RECALL LIMIT softkey.
2. Press a number representing a memory register between 0 and 51.
3. Press the (ENTER) key.

# Tutorial: Creating upper/lower limit lines

This procedure should take you about 10 minutes to complete. It shows the basics of creating limit lines.




**Upper/lower limit lines**

The following procedure guides you through the task of creating a limit line centered at 50 MHz. The limit line contains both upper and lower limits. Limit lines are divided into segments, with each segment defining an amplitude limit for a range of frequencies.

**limit-line amplitude units**

After display normalization, the amplitude units displayed for limit lines and entered using the front panel are in dBm (decibels relative to 1 mW). However, because of display normalization, the units actually used are decibels (dB). The power levels are relative to the normalized reference level.

The data entered to create the limit line is shown in the following table.

**Upper/Lower limit line Example Data**

| Segment | Start Frequency | Upper Amplitude | lower Amplitude | Type |
|---|---|---|---|---|
| 1 | 28.00 MHz | -55.0 dBm | *** | SLOPE |
| 2 | 40.00 MHz | -55.0 dBm | *** | SLOPE |
| 3 | 48.00 MHz | -5.0 dBm | -20.0 dBm | SLOPE |
| 4 | 52.00 MHz | -5.0 dBm | -20.0 dBm | SLOPE |
| 5 | 60.00 MHz | -55.0 dBm | *** | SLOPE |
| 6 | 72.00 MHz | -55.0 dBm | *** | SLOPE |

## Step 1. Set the DISPLAY SETTINGS

When creating a limit line it is convenient to view the limit lines as you create them. Set the frequency and span so that the desired frequency range is viewed.

1. Press the FREQUENCY key and enter 50 MHz.
2. Press the SPAN key and enter 50 MHz.

## Step 2. Enter the menu

1. Press the (MEAS/USER) key.
2. Press the More 1 of 2 then Limit Lines softkeys.
3. Press the LIMITEST ON OFF softkey so that ON is underlined.

   Turning limitest on allows you to view the limit lines as you create them.

4. Press the NEW LIMIT softkey twice.

   Any previously entered limit line data is lost. Pressing the softkey twice prevents accidental erasure. Data previously saved using the SAVE LIMIT softkey is not erased.

   You'll notice the LIMITS FIX REL softkey has FIX underlined. This indicates that the limit lines are fixed with respect to the center frequency and span. (This means you can change the center frequency such that the limit lines is no longer displayed.) If you want the limit line to track the center frequency, press the LIMITS FIX REL softkey so that REL is underlined.

   When NEW LIMIT is pressed, the normalized reference position is automatically set to 8.

5. Press the EDIT UP/LOW softkey.

## Step 3. Enter the first segment

A total of five segments will be used to define the limit line. This step enters the starting frequency for the first limit-line segment.

1. Press the SELECT SEGMENT softkey.
2. Enter 1 to select the first segment.
3. Press SELECT FREQ and enter 30 MHz.
4. Press SELECT UPR AMPL and enter -55 dBm.

## Step 4. Enter the second segment

1. Press the SELECT SEGMENT softkey.
2. Enter 2 to select the second segment.
3. Press SELECT FREQ and enter 40 MHz.
4. Press SELECT UPR AMPL and enter -50 dBm.

## Step 5. Enter the third segment

1. Press the SELECT SEGMENT softkey.
2. Enter 3 to select the third segment.
3. Press SELECT FREQ and enter 48 MHz.
4. Press SELECT UPR AMPL and enter -5 dB.
5. Press SELECT LWR AMPL and enter -20 dBm.

## Step 6. Enter the fourth segment

1. Press the SELECT SEGMENT softkey.
2. Enter 4 to select the fourth segment.
3. Press SELECT FREQ and enter 52 MHz.
4. Press SELECT UPR AMPL and enter -5 dBm.
5. Press SELECT LWR AMPL and enter -20 dB.

## Step 7. Enter the fifth segment

1. Press the SELECT SEGMENT softkey.
2. Enter 5 to select the fifth segment.
3. Press SELECT FREQ and enter 60 MHz.
4. Press SELECT UPR AMPL and enter -50 dBm.

## Step 8. Enter the sixth segment

1. Press the SELECT SEGMENT softkey.
2. Enter 6 to select the sixth segment.
3. Press SELECT FREQ and enter 70 MHz.
4. Press SELECT UPR AMPL and enter -50 dBm.

## Step 9. Exit and save the limit lines

1. Press the More 1 of 2 softkey
2. Press the EDIT DONE softkey.

   When you leave the limit line editing menu, limit line testing is automatically turned off and the limit lines are not longer displayed on the screen. The limit line data is now stored in volatile *RAM memory*.

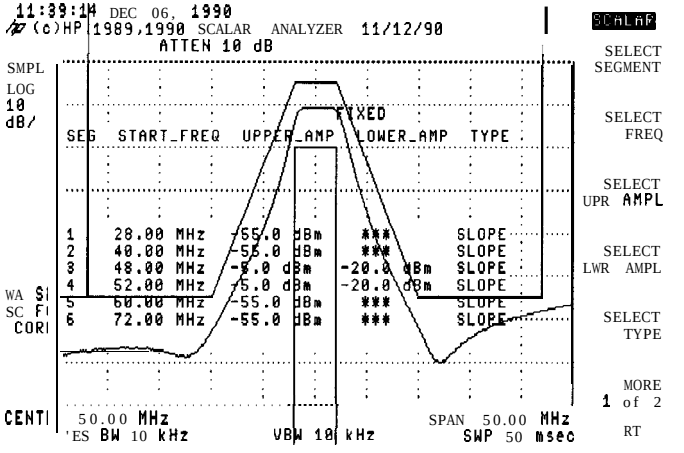
3. Press the SAVE LIMIT softkey.

   You must save the limit line data in non-volatile RAM to protect loss from an instrument preset, power disruption, or creating another limit line.

4. Press 1 and the (ENTER) key to select memory register 2.
5. Press the (ENTER) key.

# Tutorial: Creating mid/delta limit lines

This procedure should take you about 10 minutes to complete. It shows the basics of creating limit lines.




**Mid/Delta limit lines**

The following procedure guides you through the task of creating a limit line centered at 50 MHz. The limit line contains both upper and lower limits. Limit lines are divided into segments, with each segment defining an amplitude limit for a range of frequencies.

**Limit-line amplitude units**

After display normalization, the amplitude units displayed for limit lines and entered using the front panel are in dBm (decibels relative to 1 mW). However, because of display normalization, the units actually used are decibels (dB). The power levels are relative to the normalized reference level.

The data entered to create the limit line is shown in the following table.

**Mid/Delta limit line Example Data**

| Segment | Start Frequency | Middle Amplitude | Delta Amplitude | Type |
|---|---|---|---|---|
| 1 | 28.00 MHz | -55.0 dBm | *** | SLOPE |
| 2 | 40.00 MHz | -55.0 dBm | *** | SLOPE |
| 3 | 48.00 MHz | -12.5 dBm | -7.5 dBm | SLOPE |
| 4 | 52.00 MHz | -12.5 dBm | -7.5 dBm | SLOPE |
| 5 | 60.00 MHz | -55.0 dBm | *** | SLOPE |
| 6 | 72.00 MHz | -55.0 dBm | *** | SLOPE |

## Step 1. Set the display settings

1. Press the [FREQUENCY) key and enter 50 MHz.
2. Press the (SPAN) key and enter 50 MHz.

When creating a limit line it is convenient to view the limit lines as you create them. These steps set the frequency and span so that the desired frequency range is viewed.

## Step 2. Enter the menu

1. Press the (MEAS/USER) key.
2. Press the More 1 of 2 then Limit Lines softkeys.
3. Press the LIMITEST ON OFF softkey so that ON is underlined.

   Turning limitest on allows you to view the limit lines as you create them.

4. Press the NEW LIMIT softkey twice.

   Any previously entered limit line data is lost. Pressing the softkey twice prevents accidental erasure. Data previously saved using the SAVE LIMIT softkey is not erased.

   You'll notice the LIMITS FIX REL softkey has FIX underlined. This indicates that the limit lines are fixed with respect to the center frequency and span. (This means you can change the center frequency such that the limit lines is no longer displayed.) If you want the limit line to track the center frequency, press the LIMITS FIX REL softkey so that REL is underlined.

   When NEW LIMIT is pressed, the normalized reference position is automatically set to 8.

5. Press the EDIT UP/LOW softkey.

## Step 3. Enter first segment

A total of five segments will be used to define the limit line. This step enters the starting frequency for the first limit-line segment.

1. Press the SELECT SEGMENT softkey.
2. Enter 1 to select the first segment.
3. Press SELECT FREQ and enter 30 MHz.
4. Press SELECT MID AMPL and enter -50 dBm.

## Step 4. Enter the second segment

1. Press the SELECT SEGMENT softkey.
2. Enter 2 to select the second segment.
3. Press SELECT FREQ and enter 40 MHz.
4. Press SELECT MID AMPL and enter -50 dBm.

## Step 5. Enter the third segment

1. Press the SELECT SEGMENT softkey.
2. Enter 3 to select the third segment.
3. Press SELECT FREQ and enter 48 MHz.
4. Press SELECT MID AMPL and enter -12.5 dBm.
5. Press SELECT DLT AMPL and enter -7.5 dBm.

## Step 6. Enter the fourth segment

1. Press the SELECT SEGMENT softkey.
2. Enter 4 to select the fourth segment.
3. Press SELECT FREQ and enter 52 MHz.
4. Press SELECT MID AMPL and enter -12.5 dBm.
5. Press SELECT DLT AMPL and enter -7.5 dBm.

## Step 7. Enter the fifth segment

1. Press the SELECT SEGMENT softkey.
2. Enter 5 to select the fifth segment.
3. Press SELECT FREQ and enter 60 MHz.
4. Press SELECT UPR AMPL and enter -50 dBm.

## Step 8. Enter the sixth segment

1. Press the SELECT SEGMENT softkey.
2. Enter 6 to select the sixth segment.
3. Press SELECT FREQ and enter 70 MHz.
4. Press SELECT UPR AMPL and enter -50 dBm.

## Step 9. Exit and save the limit lines

1. Press the More 1 of 2 softkey.
2. Press the EDIT DONE softkey.

   When you leave the limit line editing menu, limit line testing is automatically turned off and the limit lines are no longer displayed on the screen. The limit line data is now stored in volatile RAM *memory*.

3. Press the SAVE LIMIT softkey.

   You must save the limit line data in non-volatile RAM to protect loss from an instrument preset, power disruption, or creating another limit line.

4. Press 2 and the (ENTER) key to select memory register 2.
5. Press the (ENTER) key.

# 6

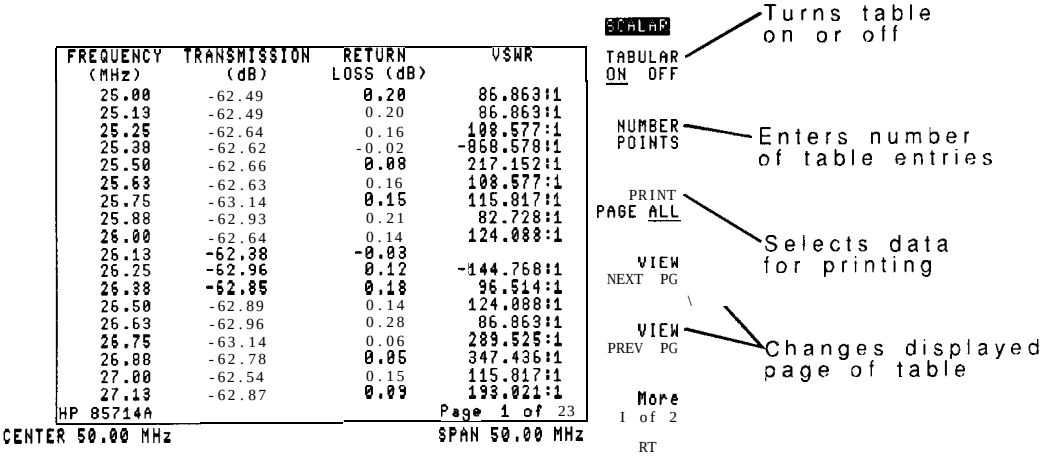
# Displaying Results in a Table

# Displaying Results in a Table

The scalar measurement personality's Tabular Display feature displays transmission and reflection results in a table. The displayed results consist of the values of each of the 401 trace measurement points. The table can then be printed on a Hewlett-Packard printer. A compress feature is available for reducing the number of table entries.

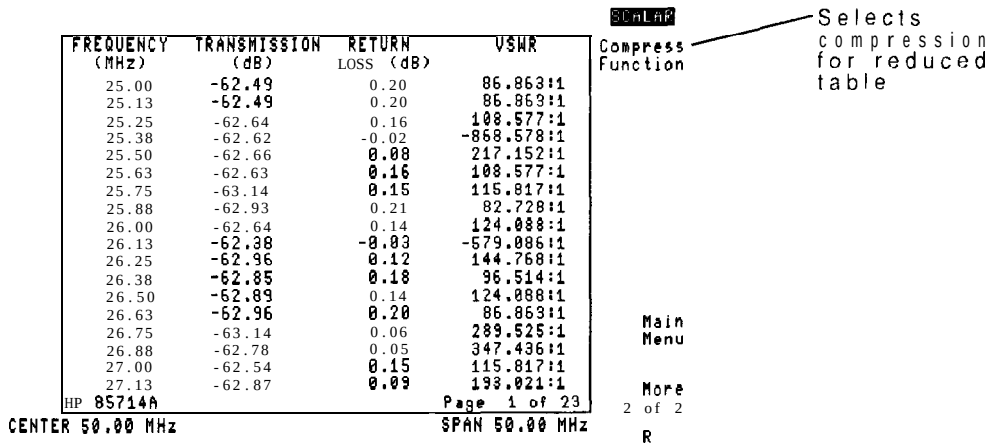
# Creating a table

Tabular Display is located in the Display menu, and is reached by pressing the DISPLAY key and then the Tabular Display softkey. When turned on, Tabular Display places the scalar measurements personality in single-sweep mode.




**Page one of Tabular Display menu**

Results are displayed only for normalized transmission and return loss (reflection) responses. The scalar measurements personality's dual display feature must be turned on in order to fill the table with both transmission and return loss results. Table entries are listed as UNCAL if a calibration has not been performed.




**Page two of Tabular Display menu**

## To view a table

1. Display a normalized transmission and/or reflection response as described in the previous chapters.
2. Press the front-panel (DISPLAY) key.
3. Press the Tabular Display softkey.
4. Press the TABULAR ON OFF softkey so that ON is underlined.
5. Use the VIEW NEXT PG and VIEW PREV PG softkeys to scroll through the table.

# Printing a table

In order to print the table, you must first connect a graphics printer, and then configure the scalar analyzer for the printer. For detailed information on configuring the printer and spectrum analyzer, refer to the printer and spectrum analyzer manuals.

Examples of graphics printers include the following Hewlett Packard printers:

- ThinkJet
- QuietJet
- LaserJet
- PaintJet

## To configure the printer

1. Configure the printer for the interface used. This will vary depending on RS-232 or HP-IB interfaces.

   Refer to the printer manual for any switch settings. Refer to the spectrum analyzer manual for information on RS-232 interfacing.

2. Connect the printer.
3. Press the scalar analyzer's front-panel (CONFIG) key.
4. Press the COPY DEV PRNT PLT softkey so that PRNT is underlined.
5. Press the PRINT CONFIG softkey.
6. Press the softkey to select the appropriate printer.
7. If an HP-IB interface is used to connect the printer, press PRINTER ADDRESS , and enter the address of the printer.

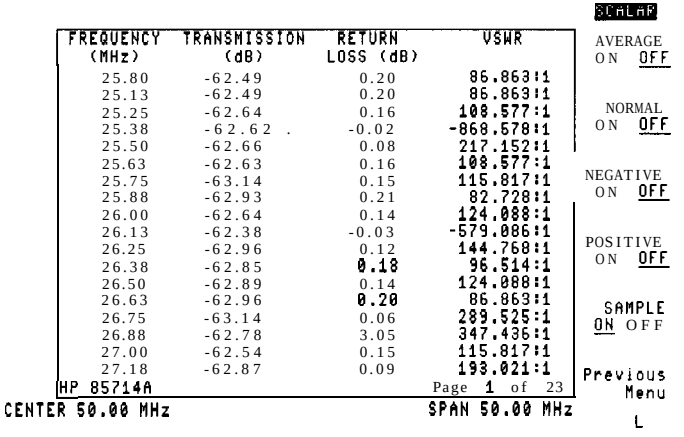
## To print the table

1. View the table on the screen as previously described in this chapter.
2. To indicate that the complete table should be printed, press the PRINT PAGE ALL softkey so that ALL is underlined. To indicate only the displayed table page should be printed, press the softkey so that PAGE is underlined.
3. Press the front-panel [copy) key.

# Reducing the number of table entries

Transmission and reflection response traces are displayed using 401 measurement points. This results in 401 table entries. The number of table entries can be compressed while retaining the relative frequency and amplitude characteristics of the original response.

The source trace data is divided into intervals equal to the number desired table entries. The data in each interval is compressed to obtain a table entry. Tabular display offers five data compression methods: AVERAGE, NORMAL, NEGATIVE, POSITIVE, and SAMPLE.



With AVERAGE compression, the data in each interval is averaged to obtain the table entry.

With NORMAL compression, the data in each interval is obtained using a Rosenfell algorithm. The Rosenfell algorithm is a mathematical operation that selectively chooses between positive and negative peak values in the interval.

With NEGATIVE compression, the lowest value data in each interval is placed in the table entry.

With POSITIVE compression, the highest value data in each interval is placed in the table entry.

With SAMPLE compression, the last value in each interval is placed in the table entry.

## To reduce tabular entries

1. Press (DISPLAY) and then the Tabular Display softkey to enter the Tabular Display menu.
2. Press the NUMBER POINTS softkey, and enter the desired number of table entries.

## To select the compression method

1. Press (DISPLAY) and then the Tabular Display softkey to enter the Tabular Display menu.
2. Press the More 1 of 2 softkey.
3. Press the Compress Function softkey.
4. Press the softkey corresponding to the desired compression method.

7

# Programming

# Programming

This chapter presents programming techniques for sending commands and receiving data. You can program the HP 85714A scalar measurements personality using the programming commands listed in Chapter 8, Reference. For information on programming the spectrum analyzer, refer to the spectrum analyzer's programming manual.

# Sending commands

Always place the spectrum analyzer in the scalar analyzer mode *before* sending any scalar measurement commands. To place the spectrum analyzer in the scalar measurements personality mode, press (MODE) and then SCALAR ANALYZER.

All scalar analyzer commands begin with the characters ns,. For example, the command to preset the scalar analyzer is **ns_MP**. Chapter 8 documents all available scalar measurements personality commands. Chapter 8 also contains a table grouping all commands according to function.

While the scalar measurements personality is operating, some spectrum analyzer commands should not be used. For example, instead of the analyzer's FFT command, use the ns-FFT command documented in Chapter 8. Refer to Chapter 8 for a list of all replaced spectrum analyzer commands.

# Output examples

Send commands as ASCII strings. The method used depends on the programming language and environment used. Using an HP 9000 Series 300 technical computer with the HP-BASIC language, send the command to the spectrum analyzer as follows:

```
OUTPUT 718;"ns_MP;"
```

Using an HP Vectra computer with the HP-IB Interface and Command Library (and programming in *C*), the same command could be sent as follows:

```
iooutputs(718L,"ns_MP;",6);
```

## Using the MOV command

It is recommended that the MOV command be used to execute all programming commands that take number parameters. Using the MOV command is faster and avoids displaying text on the analyzer screen. For example, to set the reference level using the BASIC language, send the following:

```
OUTPUT718;"MOVns_RL,-10;"
```

## To send a scalar analyzer command

1. Connect the spectrum analyzer to the computer using either the HP-IB or RS-232 interface.

   Refer to the spectrum analyzer's programming manual for information on connecting the interface.

2. Locate the appropriate command in Chapter 8.
3. Use your programming language's output statement to send the command as an ASCII string to the spectrum analyzer.

Many programming commands can be sent as queries requesting the state of the scalar measurements personality. For example, ns-NORM? requests whether normalization is turned on or off. The command reference in Chapter 8 documents available command queries.

Automatic measurement results are stored in spectrum analyzer variables. The contents of these variables can be requested by your application program to obtain measurement results. The measurements and their variables are listed in the following table.

**Measurement Variables**

| Measurement | Variable |
|---|---|
| VSWR | ns-VSWF |
| transmission coefficient | ns_MTC |
| reflection coefficient | ns-MRC |
| bandwidth | ns_DBW |
| center frequency | ns-OCF |
| shape factor | ns-DSF |
| Q | ns_DBQ |
| insertion loss | ns-OIL |

Queries and variables are normally sent from the spectrum analyzer in the form of ASCII strings. It is your responsibility to allocate memory for them in your application.

## To return a measurement value

1. Send to the spectrum analyzer an ASCII string consisting of the variable name with the ? character appended.

   For example, to return the shape factor, send `ns_DSF?`.

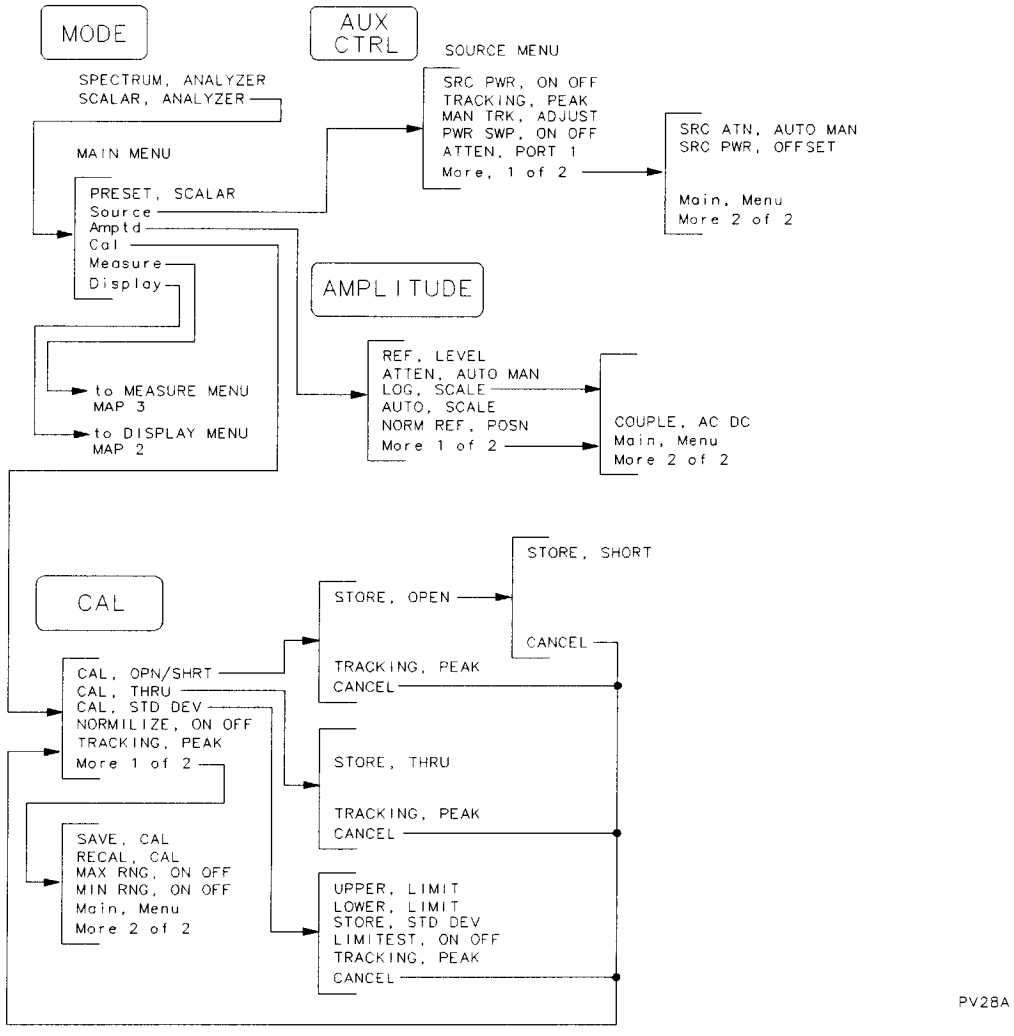
# Reference

# Reference

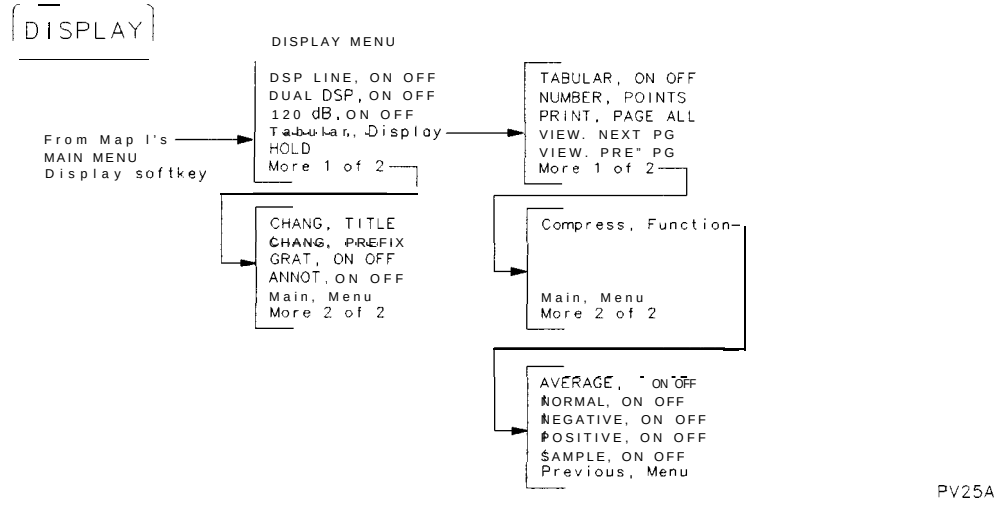
This chapter gives you quick access to information on the scalar measurements personality. The chapter contains four sections: menu maps, definitions of keys, programming commands, and characteristics. Within each section, the material is organized alphabetically.

# Menu maps

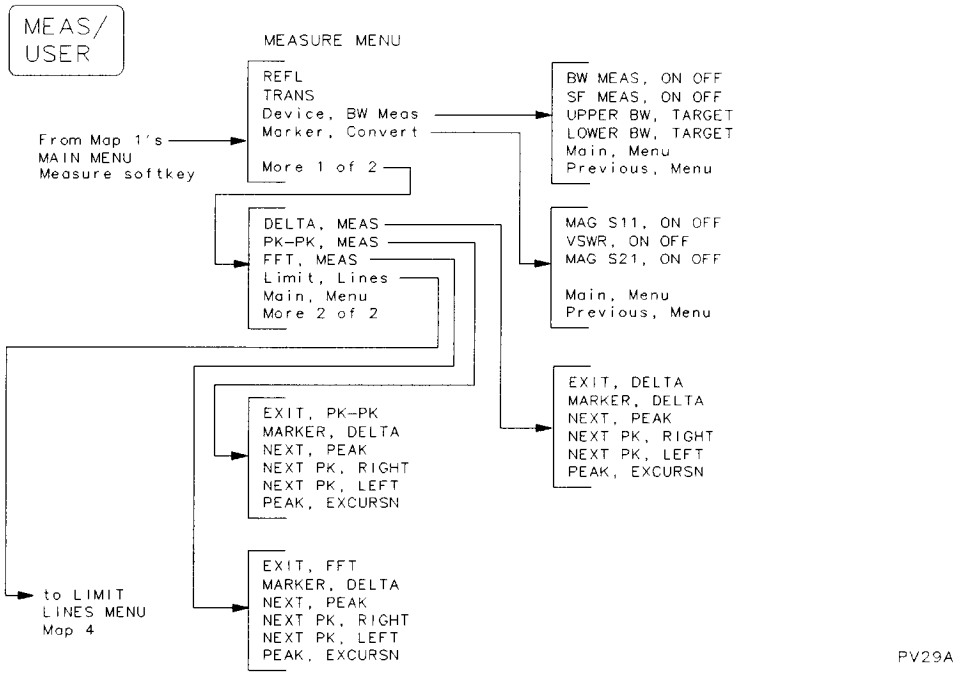
Menu maps illustrate how softkeys are located relative to each other; they help you form a "mental" map of instrument functions. The five menu maps in this section graphically represent softkey paths and include front-panel keys used to access the menus.



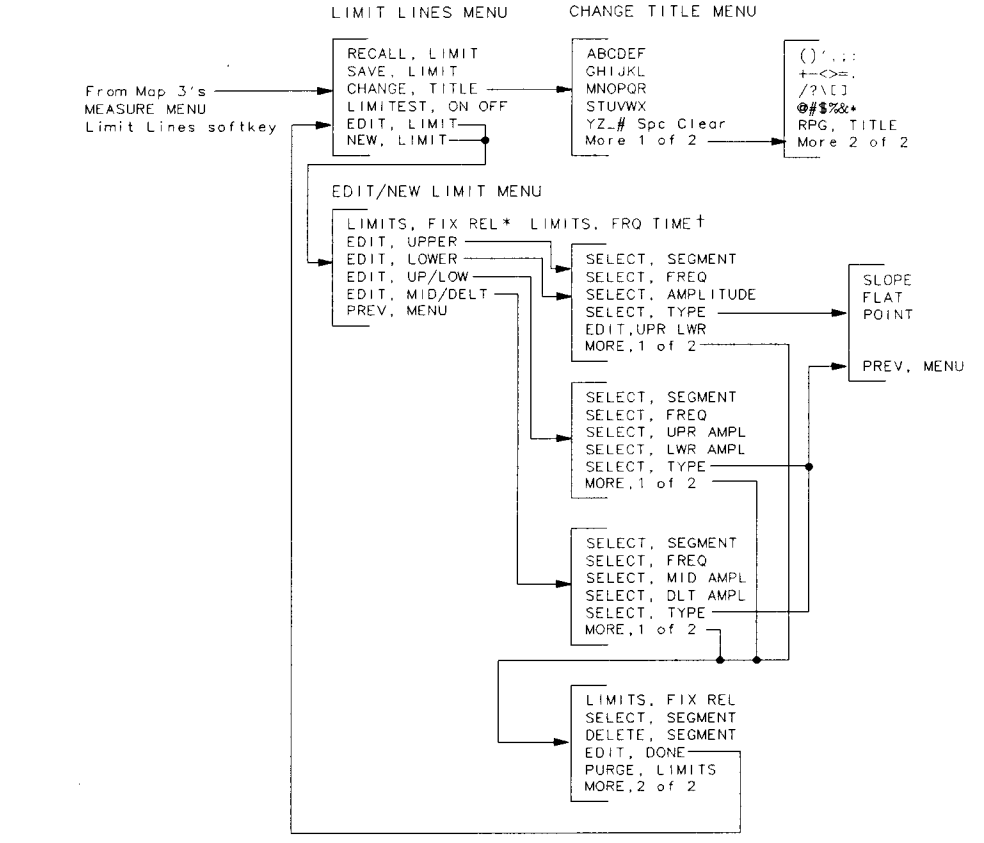

**Map 1. Main, Source, Amplitude, and Calibration Menus**




**Map 2. Display and Tabular Display Menus**



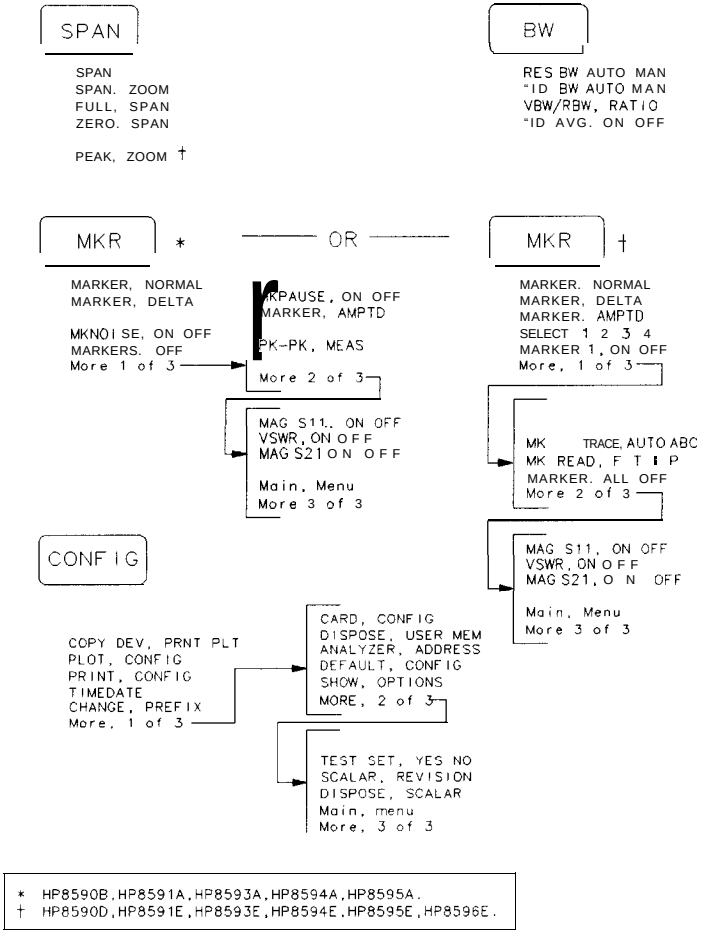

**Map 3. Measure Menu**




**Map 4. Limit Lines Menu**

# Additional redefined front-panel keys

The HP 85714A scalar measurements personality redefines the softkeys associated for several front-panel keys not listed in the scalar analyzer menu. The softkey maps for these redefined keys are shown on this page.




**Map 5. Redefined Front-Panel Keys**

# Definitions of keys

This section lists in alphabetical order the definitions of all HP 85714A scalar measurements personality keys. Alphabetically listed definitions give you a quick access to information concerning any key or softkey. Some front-panel keys have been redefined to allow quick access of scalar analyzer functions.

Refer to the spectrum analyzer's operating manual for information on any key not affected by the personality.

## 120 dB ON OFF

The 120 dB ON OFF softkey displays 120 dB of calibrated measurement range.

This feature provides 120 dB of measurement range not available with the normal 15 dB per division log scale. The 120 dB calibrated measurement range is achieved by splicing two separate traces. For each visible sweep, the scalar analyzer first saves the top 50 dB of trace data. Then, the reference level is set up to 50 dB below the current reference level and another reading is taken. Finally, these two traces are spliced together and displayed on the screen.

You cannot use this feature in the dual display mode. (Dual display refers to simultaneously displaying both transmission and reflection responses.)

The default setting for this measurement is OFF.

Related Programming Command

ns-EDR

## AMPLITUDE

The front panel AMPLITUDE key presents the scalar analyzer's Amplitude menu.

This key is identical to pressing the scalar analyzer's Amptd softkey. Use this menu to control the log scale, reference level, and input attenuation.

## Amptd

The Amptd softkey enters a menu used for controlling the log scale, reference level, and input attenuation. This softkey is identical to pressing the scalar analyzer's AMPLITUDE key.

## ANNOT ON OFF

The ANNOT ON OFF softkey turns the displayed annotation text on or off.

Related Programming Command: ns_ANNOT

## ATTEN AUTO MAN

The **ATTEN** AUTO MAN softkey selects automatic or manual RF input attenuation control.

Signal levels above +30 dBm will damage the spectrum analyzer.

**AUTO.**

The RF input attenuator is coupled to the reference level. When a continuous wave signal is displayed with its peak at or below the reference level, attenuator coupling keeps the signal level at the internal RF mixer at or below the specified level.

**MAN.**

The RF input attenuator is not coupled to the reference level. Its value can be set independently. In certain situations, increasing the input attenuation may reduce signal compression in the presence of broadband signals.

See Also

*AUTO SCALE* in this chapter.

## ATTEN PORT 1

The **ATTEN** PORT 1 softkey controls the attenuator in Option 001 HP 85630A scalar transmission/reflection test sets.

The test set has an input attenuator which reduces the power applied to its PORT 1 output connector. The default attenuation is 0 dB.

Related Programming Command

ns-EXATN

# AUTO SCALE

The AUTO SCALE softkey automatically adjusts the log scale to display a signal full screen.

This function is a one-time adjustment. The log scale does not continually update with each new trace acquisition.

Related Programming Command

ns_AUTOSC

## AUX CTRL

The AUX CTRL key presents the scalar analyzer's Source menu.

The Source menu controls the RF output of the spectrum analyzer's tracking generator. It can also be used to set the optional attenuator on the HP 85630A test set.

# AVERAGE ON OFF

The **AVERAGE** ON OFF softkey selects average compression for the Tabular Display feature.

Tabular display lists each transmission and/or reflection measurement point as an entry in a table. Traces comprise 401 measurement points resulting in 401 table entries. The number of table entries can be compressed while retaining the relative frequency and amplitude characteristics of the original response.

If the table is compressed, the source trace data is divided into intervals equal to the number desired table entries. The data in each interval is compressed to obtain a table entry. With average compression, the data in each interval is averaged to obtain the table entry.

Related Programming Command

ns-TCA

# BW

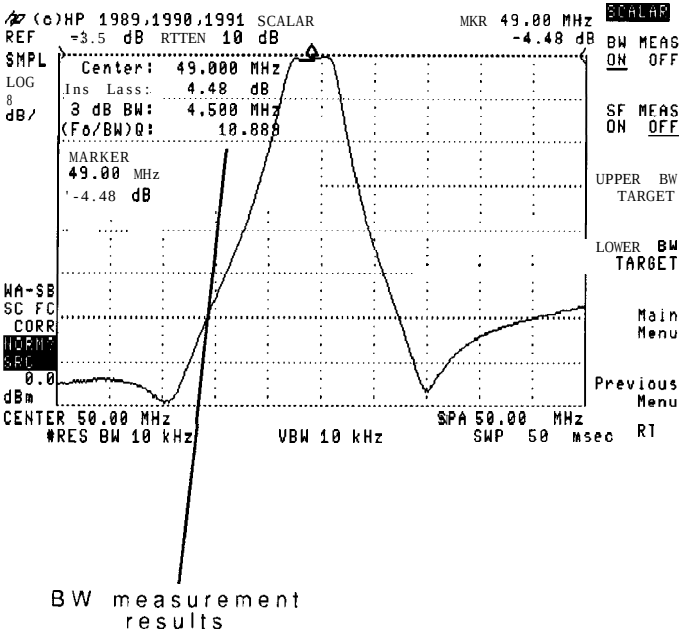
The BW key presents a menu for controlling the scalar analyzer's bandwidth.

# BW MEAS ON OFF

The BW MEAS ON OFF softkey automatically performs bandwidth measurements on a transmission response.

Parameters measured include the following:

- center frequency
- insertion loss
- bandwidth
- Q




The measurement uses a default bandwidth of 3 dB. Use the UPPER BW TARGET softkey to change the bandwidth used in the measurement. (The displayed LOWER BW TARGET softkey is not used in this

measurement.) For example, using the UPPER BW TARGET softkey, you could change the bandwidth used in the measurement from 3 dB to 6 dB.

The bandwidth measurement repeats continuously until turned off.

Related Programming Command: ns-BMT

See Also: *SF MEAS* ON *OFF* in this chapter.

---

## CAL

The CAL key presents the scalar analyzer's calibration menu.

The scalar analyzer provides guided calibration routines for both transmission and reflection measurements.

---

## Cal

The Cal softkey presents the scalar analyzer's calibration menu.

The scalar analyzer provides guided calibration routines for both transmission and reflection measurements.

## CAL OPN/SHRT

The CAL OPN/SHRT softkey preforms a guided calibration for reflection measurements.

Reflection calibration requires both *open* and *short* standards. The HP 85032B Option 001 Calibration Kit supplies 50Ω type N *open* and *short* standards for calibration.

After calibration, normalization is turned on as indicated by the screen annotation NORM displayed on the lower left side of the screen. Turn normalization on or off using the NORMALIZE ON OFF softkey.

Related Programming Command: ns_CALR

See Also: *NORMALIZE* ON *OFF* in this chapter.

## CAL STD DEV

The CAL STD DEV softkey preforms a guided calibration for transmission measurements using a standard device.

After calibration of the standard device, a limit line is created around the response of the device. This feature allows repeated response testing in production-line environments.

Standard device calibration requires a through-line. After calibration, normalization is turned on as indicated by the screen annotation "NORM" displayed on the lower left side of the screen. Turn normalization on or off using the Cal, NORMALIZE ON OFF softkey.

Related Programming Command: ns_CALS

## CAL THRU

The CAL THRU softkey preforms a guided calibration for transmission measurements.

Transmission calibration requires a through-line. After calibration, normalization is turned on as indicated by the screen annotation "NORM" displayed on the lower left side of the screen. Turn normalization on or off using the NORMALIZE UN OFF softkey.

Related Programming Command: ns-CALT

See Also: *NORMALIZE ON OFF* in this chapter.

## CANCEL

The CANCEL softkey cancels the current calibration routine and returns to the Cal menu.

NS_CAN

## CHANGE TITLE

The CHANCE TITLE softkey presents a menu for writing titles on the screen.

## CHANGE PREFIX

The CHANGE PREFIX softkey changes the prefix used in saving and recalling data to and from the memory card. You can also catalog by prefix. The default prefix is SCALAR.

The prefix can be from one to seven characters long. The longer the prefix, the shorter the register number must be. The total length of the prefix and register number cannot exceed eight characters, The prefix can be any character; however, the underscore should not be the first character of the prefix.

Pressing CHANGE PREFIX accesses a menu containing the letters of the alphabet, the underscore symbol (_), the number symbol (#), a space, and the clear function. To select a character, press the softkey that displays the group of characters that contains the desired character. The softkey menu changes to allow you to select an individual character. If you make a mistake, press [BK SP] to space back over the incorrect character. Additional characters are available by pressing YZ_# SPC CLEAR , MORE 1 OF 2 Numbers may be selected with the numeric keypad.

A prefix can be cleared with the clear function. Press [DISPLAY], CHANGE PREFIX , YZ_# SPC CLEAR, CLEAR to clear the current prefix.

## Compress Function

The Compress Function softkey presents a menu for compressing the data in a tabular display.

## CONFIG

The [CONFIG] key presents the scalar analyzer's Configuration Menu.

The first two menu pages are identical to the spectrum analyzer CONFIG menu. Page three provides the following features specific to the scalar analyzer:

- Turn the HP 85630A test set on or off.
- Remove the HP 85714A from the spectrum analyzer.
- Display the HP 85714A revision number.

## COUPLE DC AC

The COUPLE DC AC softkey selects either AC or DC RF input coupling on HP 8594A, HP 85943, HP 8595A, HP 85953, and HP 85963 spectrum analyzers.

## DELETE SEGMENT

The DELETE SEGMENT softkey deletes the current limit-line segment from the table.

This function removes unwanted limit lines and their values from the currently active limit-line table.

## DELTA MEAS

The DELTA **MEAS** softkey presents a menu for measuring delta amplitude and frequency values using the delta marker delta marker function.

The marker is placed on the peak of the response.

## Device BW MEAS

The Device **BW MEAS** softkey presents a menu for measuring response bandwidth and shape factor in transmission measurements.

For bandwidth measurements, the display shows the following measurement values :

- center frequency
- insertion loss
- bandwidth
- Q

For shape factor measurements, the display shows the following measurement values :

- shape factor
- upper bandwidth
- lower bandwidth

See Also

*BW MEAS* ON *OFF* and *SF MEAS* ON *OFF* in this chapter.

DISPLAY

The DISPLAY front-panel key presents the scalar analyzer's menu for controlling the display of information.

The scalar analyzer redefines the softkeys for this spectrum analyzer key with functions unique to the scalar analyzer.

## Display

The Display softkey presents a menu for controlling the display of information. From this menu, you can perform the following tasks:

- View a display line.
  The display line is an adjustable horizontal line used as a visual reference line.
- View reflection/transmission results simultaneously.
  Simultaneous viewing requires the HP 85630A scalar transmission/reflection test set.
- View 120 dB of measurement range.
- View a table of measurement results.
- Add a screen title.
- Turn on or off the graticule and/or annotation.

## DISPOSE SCALAR

The DISPOSE SCALAR removes the scalar analyzer personality from the spectrum analyzer.

Related Programming Command: ns-DISPOSE

## DSP LINE ON OFF

The DSP LINE ON OFF softkey displays an adjustable horizontal line that can be used as a visual reference.

The viewed display line is identical to the display line used by the spectrum analyzer. The line can be used for trace arithmetic and has amplitude values that correspond to its vertical position when compared to the reference level.

The display line can be adjusted using the step keys, knob, or numeric keypad.

## DUAL DSP ON OFF

The DUAL DSP ON OFF softkey allows you to view both reflection and transmission measurements at the same time.

This feature requires the optional HP 85630A scalar transmission/reflection test set. The HP 85714A controls the test set allowing you to see either reflection and transmission results in real time.

Related Programming Command: ns-DDM

See Also: *REFL* and *TRANS* and *TEST SET* ON *OFF* in this chapter.

## EDIT DONE

The EDIT DONE softkey ends the editing or creating of a limit-line table.

This function returns you to the limit-lines menu and removes limit lines from the display. However, limit lines are not saved until you save them with the SAVE LIMIT softkey. Limit lines may be viewed by pressing LIMITEST ON OFF.

See Also

*SAVE LIMIT* and *LIMITEST* ON *OFF* in this chapter.

## EDIT LIMIT

The EDIT LIMIT softkey allows you to edit limit lines.

This softkey's selections are identical to the NEW LIMIT softkey, with the exception that NEW LIMIT erases any currently active limit lines from memory. Be sure to save edited or created limit lines using the SAVE LIMIT softkey.

See Also

*SAVE LIMIT* in this chapter.

## EDIT LOWER

The EDIT LOWER softkey presents a menu for editing a limit line table by specifying lower amplitude segments.

Although this menu is optimized for editing lower limit-line segments, you can edit all limit-line values. The menu's EDIT UPR LWR softkey is selected for lower (LWR) segment editing. You can easily edit upper (UPR) segments by pressing this softkey so that UPR is underlined.

## EDIT MID/DELT

The EDIT MID/DELT softkey presents a menu for editing a limit-line table by specifying the distance between upper and lower limits lines centered around a midpoint power level.

## EDIT UP/LOW

The EDIT UPPER softkey presents a menu for editing limit-line tables. Editing is accomplished by specifying upper and lower amplitude segments.

Although this menu is optimized for editing upper limit-line segments, you can edit all limit-line values. The menu's EDIT UPR LWR softkey is selected for upper (UPR) segment editing. You can easily edit lower (LWR) segments by pressing this softkey so that LWR is underlined.

## EDIT UPPER

The EDIT UPPER softkey presents a menu for editing a limit-line table by specifying a upper segment's amplitude.

Although this menu is optimized for editing upper limit-line segments, you can edit all limit-line values. The menu's EDIT UPR LWR softkey is selected for upper (UPR) segment editing. You can easily edit lower (LWR) segments by pressing this softkey so that LWR is underlined.

## EDIT UPR LWR

The EDIT UPR LWR softkey selects a segment's upper or lower limit line for editing.

The SELECT AMPLITUD softkey changes the amplitude of the limit line specified by the EDIT UPR LWR softkey.

## EXIT DELTA

The EXIT DELTA softkey removes the DELTA MEAS menu and returns the scalar analyzer to the Measure menu.

## EXIT FFT

The EXIT FFT softkey removes the FFT MEAS menu and returns the scalar analyzer to the Measure menu.

The FFT performed by the FFT menu is removed when the EXIT FFT is pressed.

## EXIT PK-PK

The EXIT PK-PK softkey removes the PK-PK MEAS menu and returns the scalar analyzer to the Measure menu.

## FFT MEAS

The FFT **MEAS** softkey enters the FFT menu.

The scalar analyzer transforms zero span data into the frequency domain using an FFT (Fast Fourier Transform). After using the FFT function the following conditions are set:

- the display is in log mode (10 dB/division)
- triggering is single sweep
- markers are available as FFT markers

Any markers must be turned off before attempting to use them in the usual manner.

Related Programming Command: ns_FFT

## FLAT

The FLAT softkey defines a limit-line segment type. A zero-slope line is drawn between the coordinate point of the current segment and the coordinate point of the next segment. This produces limit-line values equal in amplitude for all frequencies between the two points.

See Also *SELECT TYPE* in this chapter.

## GRAT ON OFF

The GRAT ON OFF softkey turns the displayed graticule on or off.

## LIMITS FIX REL

The LIMITS FIX REL softkey determines the method used to display the limit line with respect to frequency.

**FIX.** The limit lines are displayed at the Exed frequency and reference level indicated in the limit line table.

REL. The limits lines are displayed relative to the scalar analyzer's center frequency and reference level.

## Limit Lines

The Limit Lines softkey accesses a menu for creating limit lines.

Limit lines graphically display test limits on the scalar analyzer's screen. These limits can be used for pass/fail testing. You can also enter this menu be pressing the front-panel (MEAS/USER) key followed by the **More** 1 of 2 softkey.

## LIMITEST ON OFF

The LIMITEST ON OFF softkey turns on or off limit-line testing.

ON.

Any currently active limit lines are displayed with transmission or reflection pass/fail conditions indicated on the screen.

**OFF.** No limit lines are active or displayed.

## LOG SCALE

The LOG SCALE softkey allows you to manually change the display's log scale.

See Also

*AUTO SCALE* in this chapter.

## LOWER BW TARGET

The LOWER BW TARGET softkey changes the bandwidth used in filter shape-factor measurements.

The default lower bandwidth value is -60 dB.

$$shape\ factor = \frac{60\ dB\ response\ bandwidth}{3\ dB\ response\ bandwidth}$$

Related Programming Command

ns-LBW

See Also

*SF MEAS* ON *OFF* in this chapter.

## LOWER LIMIT

The LOWER LIMIT softkey is used when calibrating standard devices. It sets the acceptable deviation in dB between the lower limit trace and the response of the standard device.

Related Programming Command

ns-SDLL

# MAG S11 ON OFF

The MAG Sll ON OFF softkey measures the reflection coefficient during a reflection measurement.

The display must be normalized. A moveable marker is activated for measuring the reflection coefficient at any point on the displayed response. The reflection coefficient is defined as the ratio of the reflected signal voltage from a device being tested to the incident signal voltage. It is shown by the following formula:

$$\Gamma = \frac{E_{reflected}}{E_{incident}}$$

The MAG S11 ON OFF function does not give measurement results during transmission measurements.

Related Programming Command
ns-MCT
ns-MCM

See Also
*VSWR* ON *OFF* in this chapter,

# MAG S21 ON OFF

The MAG S21 ON OFF softkey measures the transmission coefficient during a transmission measurement.

The display must be normalized. A moveable marker is activated for measuring the transmission coefficient at any point on the displayed response. The transmission coefficient is defined as the ratio of the voltage at the output of a device to the voltage at the input of a device. It is shown by the following formula:

$$T = \frac{E_{output}}{E_{input}}$$

The MAG S21 ON OFF function does not give measurement results during reflection measurements.

Related Programming Command

ns-MCT
ns-MCM

## Main Menu

The Main Menu softkey returns the scalar analyzer to the main menu.

## MAN TRK ADJUST

The MAN TRK ADJUST softkey manually adjusts the source's tracking.

This function allows you to manually adjust the frequency tracking between the scalar analyzer and the built-in tracking generator. The frequency tracking is correctly set when the displayed response is peaked for maximum amplitude.

See Also

*TRACKING PEAK* in this chapter.

## Marker Convert

The Marker Convert softkey presents a menu for measuring VSWR, $S_{11}$ magnitude, and $S_{21}$ magnitude.

Menu selections activate a moveable marker that display the appropriate scalar value. For reflection measurements, the marker can indicate either VSWR or $S_{11}$ magnitude (reflection coefficient). For transmission measurements, the marker indicates the $S_{21}$ magnitude (transmission coefficient).

Related Programming Command

ns-MCM

See Also

*MAG S11* ON *OFF*, *MAG S21* ON *OFF*, and *VSWR* ON *OFF* in this chapter.

## MARKER DELTA

The MARKER DELTA softkey places delta markers on the screen.

Two markers are placed on the screen: an anchor marker and a movable marker. The anchor marker is stationary and is placed on the peak response. The scalar analyzer places the movable marker on the lowest signal response. As the front-panel knob moves the movable marker, the display shows the difference in frequency and amplitude between the two markers.

## MAX RNG ON OFF

The MAX RNG ON OFF softkey displays a horizontal line indicating the upper limit of display calibration.

Because normalization shifts the response, a portion of the displayed response may be uncalibrated. This function graphically indicates uncalibrated portions of a response. If the response enters an uncalibrated area, the message 'DISPLAY OVER-RANGE' appears on the screen.

Related Programming Command: ns-URNG

See Also: *MIN* RNG ON *OFF* in this chapter,

# Measure

The Measure softkey presents a menu for performing reflection and transmission measurements.

Use this menu to switch between transmission and reflection measurements and to measure response parameters.

## MEAS/USER

The MEAS/USER front-panel key presents the scalar analyzer's Measure menu.

This key is identical to pressing the scalar analyzer's Measure softkey. Use this menu to switch between transmission and reflection measurements and to measure response parameters. The second time the key is pressed, the user menu appears.

# MIN RNG ON OFF

The MIN RNG ON OFF softkey displays a horizontal line indicating the lower limit of display calibration.

Because normalization shifts the response, a portion of the displayed response may be uncalibrated. This function graphically indicates uncalibrated portions of a response. If the response enters an uncalibrated area, the message 'DISPLAY UNDER-RANGE' appears on the screen.

Related Programming Command

ns_LRNG

See Also

*MAX RNG* ON *OFF* in this chapter.

## NEGATIVE ON OFF

The NEGATIVE ON OFF softkey selects negative compression for the Tabular Display feature.

Tabular display lists each transmission and/or reflection measurement point as an entry in a table. Traces comprise 401 measurement points resulting in 401 table entries. The number of table entries can be compressed while retaining the relative frequency and amplitude characteristics of the original response.

If the table is compressed, the source trace data is divided into intervals equal to the number desired table entries. The data in each interval is compressed to obtain a table entry. With negative compression, the lowest value data in each interval is placed in the table entry.

Related Programming Command: ns-TCA

## NEW LIMIT

The NEW LIMIT softkey allows you to create a limit line table.

The selections with this softkey are identical to EDIT LIMIT with the exception that NEW LIMIT erases any currently active limit-line table.

See Also: *EDIT LIMIT* in this chapter.

## NEXT PEAK

The NEXT PEAK softkey locates the next highest trace point relative to the current marker position.

The next peak must meet the current peak excursion criteria in order to be located.

See Also

*PEAK EXCURSN* in this chapter.

## NEXT PK LEFT

The NEXT PK LEFT softkey locates the next signal peak to the left of the current marker position.

The next peak must meet the current peak excursion criteria in order to be located.

See Also

*PEAK EXCURSN* in this chapter.

## NEXT PK RIGHT

The NEXT PK RIGHT softkey locates the next signal peak to the left of the current marker position.

The next peak must meet the current peak excursion criteria in order to be located.

See Also

*PEAK EXCURSN* in this chapter.

## NORM REF POSN

The NORM REF POSN softkey sets the normalized reference position.

This is the position of the normalized reference level after a calibration. It is indicated by an angle bracket at each end of a horizontal graticule line. The normalized reference position can be set to any of the eight major horizontal graticule lines. (Position eight is the top graticule; position 0 is the bottom graticule.) The default normalized reference position is at the display's top graticule line.

Related Programming Command: ns-NRP

## NORMAL ON OFF

The NORMAL ON OFF softkey selects normal compression for the Tabular Display feature.

Tabular display lists each transmission and/or reflection measurement point as an entry in a table. Traces comprise 401 measurement points resulting in 401 table entries. The number of table entries can be compressed while retaining the relative frequency and amplitude characteristics of the original response. If the table is compressed, the source trace data is divided into intervals equal to the number desired table entries. The data in each interval is compressed to obtain a table entry. With normal compression, the data in each interval is obtained using a Rosenfell algorithm. The Rosenfell algorithm is a mathematical operation that selectively chooses between positive and negative peak values in the interval.

## NORMALIZE ON OFF

The NORMALIZE ON OFF softkey turns normalization on or off.

After transmission or reflection calibration, normalization is turned on. Use this function to disable normalization.

Related Programming Command

ns-NORM

## NUMBER POINTS

The NUMBER POINTS softkey specifies the number of measurements in the tabular display.

The default value is the same as the normal number of points in a trace: 401. The trace points can be compressed to Et a reduced number of table points.

Related Programming Command

ns-TDP

## PEAK EXCURSN

The PEAK **EXCURSN** softkey determines the minimum signal excursion needed to identify a signal peak.

The NEXT PEAK , NEXT PK RIGHT , and , **NEXT** PEAK LEFT functions use this value to locate signal peaks. The default peak excursion value is 6 dB.

## PK-PK MEAS

The PK-PK **MEAS** softkey presents a menu for measuring peak-to-peak values using the delta marker function.

## POINT

The POINT softkey specifies a limit value for a single limit-line segment frequency.

See Also — *SELECT TYPE* in this chapter

## POSITIVE ON OFF

The POSITIVE ON OFF softkey selects positive compression for the Tabular Display feature.

Tabular display lists each transmission and/or reflection measurement point as an entry in a table. Traces comprise 401 measurement points resulting in 401 table entries. The number of table entries can be compressed while retaining the relative frequency and amplitude characteristics of the original response. If the table is compressed, the source trace data is divided into intervals equal to the number desired table entries. The data in each interval is compressed to obtain a table entry. With positive compression, the highest value data in each interval is placed in the table entry.

Related Programming Command — ns-TCA

# PRINT PAGE ALL

The PRINT PAGE ALL softkey selects how much of the tabular display table to print when the [COPY] key is pressed. Choices are the current displayed page or the complete table.

# PRESET SCALAR

The PRESET S&ALAR softkey presets the scalar analyzer to its default settings.

The default settings are identical to those set when the personality was installed.

**Default Settings.**

| | |
|---|---|
| Center frequency | set for full span |
| Frequency span | full span |
| Normalization | off |
| Unsaved calibration data | erased |
| Log scale | 10 dB/div |
| Dual display | off |
| Source power | on, 0 dBm |
| Source attenuation | 0 dB |
| Power sweep | off |
| Test set on/off | unchanged |

Related Programming Command

ns-MP

## PURGE LIMITS

The PURGE LIMITS softkey erases the current limit-line table from memory.

Tables previously saved in a register using SAVE LIMIT will not be erased.

## PWR SWP ON OFF

The PWR SWP ON OFF softkey controls the source's output power.

The source is the spectrum analyzer's built-in tracking generator. With the power on, use the front-panel knob, numeric keys, or step keys to adjust the power to the desired level. The default power level is 0 dBm.

## RECAL CAL

The RECAL CAL softkey recalls previously saved calibration data for normalization.

See Also *SAVE CAL* and *CAL OPN/SHRT* and *CAL THRU* in this chapter

## RECALL LIMIT

The RECALL LIMIT softkey recalls a limit-line table from memory.

The selected limit-line table is recalled, and limit testing is turned on. Limit-line tables can be recalled from any of 53 registers numbered 0 through *52.*

See Also

*SAVE LIMIT* in this chapter.

## REF LEVEL

The REF LEVEL softkey sets the reference level.

The reference level is the power in dB represented at the display's top horizontal graticule line. The scalar analyzer's input attenuator and step gains are coupled to the reference level and automatically adjusts to avoid signal compression. Because of this, changing the reference level after calibration (normalization) introduces measurement uncertainties. However, changing the reference level can be used to shift the measurement range. Changing the reference level with normalization on causes a "?" character to be displayed after the NORM annotation. This indicates that measurement accuracy may have been compromised.

Related Programming Command

ns-RL
ns-NRL

## REFL

The REFL softkey configures the scalar analyzer for displaying the reflection response of the device under test.

Related Programming Command: ns-REFL

See Also: *CAL OPN/SHRT* in this chapter.

## SAMPLE ON OFF

The SAMPLE ON OFF softkey selects sample compression for the Tabular Display feature.

Tabular display lists each transmission and/or reflection measurement point as an entry in a table. Traces comprise 401 measurement points resulting in 401 table entries. The number of table entries can be compressed while retaining the relative frequency and amplitude characteristics of the original response. If the table is compressed, the source trace data is divided into intervals equal to the number desired table entries. The data in each interval is compressed to obtain a table entry. With sample compression, the last value in each interval is placed in the table entry.

Related Programming Command: ns-TCA

## SAVE CAL

The SAVE GAL softkey saves normalization data.

To reduce measurement setup times, recall the saved calibration at a later date. Recalling the data sets the scalar analyzer's measurement settings and turns on the saved normalization.

Related Programming Command
ns_RCI
ns_SCI

See Also
*RECAL CAL* in this chapter.

## SAVE LIMIT

The SAVE LIMIT softkey saves a limit line table in one of 53 available memory registers.

These 53 registers are non-volatile memory. All data is saved even with line power is removed.

See Also
*RECALL LIMIT* in this chapter,

## SCALAR ANALYZER

The SCALAR ANALYZER softkey invokes the HP 85714A personality which places the spectrum analyzer in scalar analyzer mode.

## SCALAR REVISION

The SCALAR REVISION softkey displays the software revision number of the HP 85714A scalar measurement personality. It is displayed in the title area.

The revision number is changed by Hewlett Packard whenever modifications of the HP 85714A have occurred.

## SELECT AMPLITUD

The SELECT AMPLITUD softkey activates the current limit-line segment's amplitude for editing or entry.

Values entered affect the upper or lower limit line depending on the setting of the EDIT UPR LWR softkey. Signals occurring lower than lower limit lines or greater than upper limit lines cause a fail condition during limit-line testing.

## SELECT DLT AMPL

The SELECT DLT AMPL softkey defines the segment's delta amplitude.

The delta amplitude is the decibels separating the upper and lower limit-lines of the selected line segment.

In the EDIT MID/DELT menu, the upper and lower limit-line amplitudes are defined by a combination of the midpoint and delta values.

## SELECT FREQ

The SELECT FREQ softkey defines the segment's frequency.

The current limit-line segment's frequency is activated for editing or entry.

## SELECT LWR AMPL

The SELECT LWR AMPL softkey defines the segment's lower amplitude.

The lower limit-line amplitude is relative to the normalized reference level.

## SELECT MID AMPL

The SELECT MID AMPL softkey defines the amplitude midpoint between the upper and lower limit-line amplitudes.

In the EDIT MID/DELT menu, the upper and lower limit-line amplitudes are defined by a combination of the midpoint and delta values.

## SELECT SEGMENT

The SELECT SEGMENT softkey selects a limit-line segment for editing.

After selecting a segment, its frequency and amplitude values can be entered or changed.

# SELECT TYPE

The SELECT TYPE softkey determines the type of limit-line segments drawn between segment frequencies.

FLAT selects flat lines, SLOPE selects sloped lines, and POINT selects a point.

**FLAT.**

Draws a zero-slope line between the coordinate point of the current segment and the coordinate point of the next segment. This produces limit-line values equal in amplitude for all frequencies between the two points. If the amplitude values of the two segments differ, the limit line "steps" to the frequency value of the second segment.

**POINT.**

Specifies a limit value for one coordinate point, so that a POINT segment specifies a limit value for a single frequency. For an upper limit line, a POINT segment is indicated by a line drawn vertically from the coordinate point to a point off the top of screen. For a lower limit line, a POINT segment is indicated by a line drawn vertically from the coordinate point to a point off the bottom of screen. The POINT segment type is generally used as the last segment in the limit-line table. However, if the last segment in the table is not of the POINT segment type, an implicit point is automatically added at the right-hand side of the screen. If a visible POINT segment at the right-hand edge of the display is not desired, add an explicit last-point segment to the limit-line table that is higher in frequency than the stop frequency.

**SLOPE.**

Draws a straight line between the coordinate point of the current segment and the coordinate point of the next segment. This produces limit-line values for all frequencies between the two points.

## SELECT UPR AMPL

The SELECT UPR AMPL softkey defines the segment's upper amplitude.

The upper limit-line amplitude is relative to the normalized reference level.

## SF MEAS ON OFF

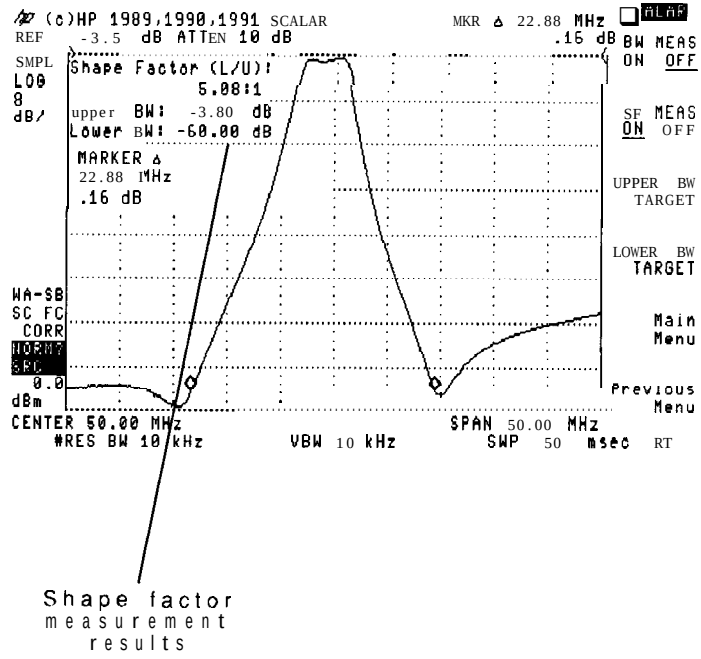
The SF MEAS ON OFF softkey measures the shape factor of a bandpass filter.

The shape factor measurement data updates with each sweep until turned off. Shape factor is a transmission measurement that characterizes the slope of a bandpass filter's skirts. Shape factor is the ratio of upper and lower bandwidths of the response. The larger the shape factor, the less selective the filter.

$$shape\ factor = \frac{lower\ response\ bandwidth}{upper\ response\ bandwidth}$$

The default bandwidths used are:

upper bandwidth . . . . . 3 dB
lower bandwidth . . . . . 60 dB




### Changing the Shape Factor Definition.

The bandwidths used to determine the shape factor can be modified by using the UPPER BW TARGET and LOWER BW TARGET softkeys. For example,

using the UPPER BW TARGET softkey, you could change the upper bandwidth used in the measurement from 3 dB to 6 dB.

### Using the HP 85630A.

The optional HP 85630A test set reduces dynamic range, To increase dynamic range, perform the measurement without the test set.

Related Programming Command: ns-BMT

See Also: *BW MEAS* ON *OFF* in this chapter.

## SLOPE

The SLOPE softkey defines a limit-line segment type. A straight line is drawn between the coordinate point of the current segment and the coordinate point of the next segment.

See Also *SELECT TYPE* in this chapter.

## Source

The Source softkey presents the scalar analyzer's Source menu.

The Source menu controls the RF output of the spectrum analyzer's tracking generator. It can also be used to set the optional attenuator on the HP 85630A test set.

See Also *AUX CTRL* in this chapter.

## (SPAN)

The front-panel (SPAN) key presents the spectrum analyzer's frequency span menu.

The scalar analyzer modifies the spectrum analyzer's Span menu by eliminating the LAST SPAM softkey.

## SRC ATN AUTO MAN

The SRC ATN AUTO MAN softkey controls the attenuation applied to the built-in tracking generator's RF output. It only applies to HP 8591A spectrum analyzers.

**MAN.**

You can manually attenuate the output level of the source from 0 to 60 dB in 10 dB steps.

**AUTO.**

The scalar analyzer automatically adjust the attenuator to yield the source amplitude level specified by the SRC PWR ON OFF softkey.

## SRC PWR OFFSET

The SRC PWR OFFSET softkey offsets the source power-level readout.

Use this function to take into account system losses or gains (for example, cable loss and preamplifier gain.) Offset the loss or gain so that the displayed power annotation reflects the actual power at the input to the device under test and not the output power of the source.

Related Programming Command: ns-SRCPOFS

## SRC PWR ON OFF

The SRC PWR ON OFF softkey controls the source (built-in tracking generator) output power.

The source's power can be turned on or off. When on, use the front-panel knob, numeric keypad, or step keys to set the output power.

The screen displays the source power level along its lower left side.

Related Programming Command: ns_SRCPWR

## STORE OPEN

The STORE OPEN softkey stores the open condition during reflection calibration.

Related Programming Command: ns-OPEN

## STORE SHORT

The STORE SHORT softkey stores the short condition during reflection calibration.

Related Programming Command: ns_SHRT

## STORE STD DEV

The STORE STD DEV softkey stores standard device transmission calibrations. When pressed, the scalar analyzer personality calculates and stores the response limits specified for the standard device.

Related Programming Command: ns_STD

## STORE THRU

The STORE THRU softkey stores the through condition during transmission calibration.

Related Programming Command: ns_THRU

## Tabular Display

The Tabular Display softkey enters a menu for displaying transmission and reflection results in a table.

The displayed table consists of the values of each of the 401 trace measurement points. The table can be printed on a Hewlett-Packard graphics printer. A compress feature is available for reducing the number of table entries.

Results are displayed only for normalized transmission and return loss (reflection) responses. The scalar analyzer's dual display feature must be turned on in order to fill the table with both transmission and return loss results. Table entries are listed as UNCAL if a calibration has not been performed.

## TABULAR ON OFF

The TABULAR ON OFF softkey turns on or off the Tabular Display feature.

When turned on, the scalar analyzer is placed in single sweep, with the measurements displayed in tabular form.

Related Programming Command: ns_TDD

## TEST SET YES NO

The TEST SET YES NO softkey turns the optional HP 85630A scalar transmission/reflection test set on or off.

This softkey informs the HP 85714A scalar analyzer if an HP 85630A is connected.

## TRACKING PEAK

The TRACKING PEAK softkey automatically adjusts the source tracking.

To ensure measurement accuracy, the frequency tracking of the source (built-in tracking generator) should periodically be adjusted to track the scalar analyzer. The tracking of the source is correctly set when the displayed response is peaked for maximum amplitude.

## TRANS

The TRANS softkey configures the scalar analyzer for displaying transmission response of the device under test.

Related Programming Command

ns_TRANS

See Also

CAL *THRU* in this chapter.

## UPPER BW TARGET

The UPPER BW TARGET softkey changes the default bandwidth used in filter measurements.

The default upper bandwidth value is used in both shape factor and bandwidth measurements. Entered values affect both measurements.

Related Programming Command

ns-UBW

See Also

*BW MEAS* ON *OFF* and *SF MEAS* ON *OFF* in this chapter.

## UPPER LIMIT

The UPPER LIMIT softkey is used when calibrating standard devices. It sets the acceptable deviation in dB between the upper limit trace and the response of the standard device.

Related Programming Command: ns-SDUL

## VIEW NEXT PG

The VIEW NEXT PG softkey displays the next Tabular Display table's page.

## VIEW PREV PG

The VIEW PREV PG softkey displays the previous Tabular Display table's page.

# VSWR ON OFF

The VSWR ON OFF softkey measures the voltage standing-wave ratio during a reflection measurement.

Normalization must be turned on. A moveable marker is activated for measuring the VSWR at any point on the displayed response. The VSWR is defined as the ratio of the minimum and maximum voltage values on a transmission line caused by reflections from a mismatch.

$$VSWR = \frac{1 + reflection\ coefficient}{1 - reflection\ coefficient}$$

The VSWR ON OFF function does not give measurement results during transmission measurements.

Related Programming Command

ns-MCT

See Also

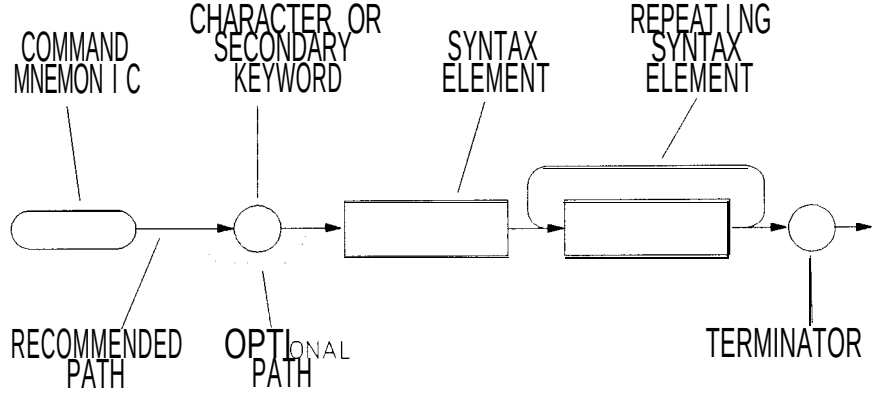
*MAG S11* ON *OFF* in this chapter.

# Programming commands

This section documents each of the scalar analyzer's remote programming commands in alphabetical order. Included for each command is a syntax diagram, a description, and an example. The following tables are located in this introduction:

- Preferred Scalar Measurement Commands
- Softkeys versus Programming Commands
- Amplitude Commands
- Calibration Commands
- Display Control Commands
- Instrument State Commands
- Measurement Mode Commands
- Source Control Commands

Each command's syntax is represented pictorially as shown below.




Syntax diagram shapes have the following meanings:

- Narrow ovals enclose command mnemonics. The command mnemonic must be entered exactly as shown.
- Circles and wide ovals surround secondary keywords, or special numbers and characters. The characters in circles and ovals are considered reserved words and must be entered exactly as shown.
- Rectangles contain the description of a syntax element defined below the syntax diagram.
- A loop above a syntax element indicates that the syntax element can be repeated.
- Solid lines represent the recommended path.
- Dotted lines indicate an optional path for bypassing secondary keywords.
- Curved intersections indicate command path direction.
- Semicolons are the recommended command terminators. Using semicolons makes programs easier to read, prevents command misinterpretation, and is recommended by IEEE Standard 728.

# Preferred commands

While the scalar measurements personality is operating, some spectrum analyzer commands should not be used. For example, instead of the analyzer's FFT command, use the NS_FFT command listed in this chapter. Using the spectrum analyzer commands may result in measurement errors.

The following table lists the spectrum analyzer commands which are replaced by commands in this chapter.

**Preferred Scalar Measurement Commands**

| Spectrum Analyzer Command | Preferred Scalar Analyzer Command |
|---|---|
| ANNOT | ns_ANNOT |
| AT | ns_AT |
| AT AUTO | ns_AT AUTO |
| FFT | ns_FFT |
| IP | ns-MP |
| LIMITEST | ns-LIMITEST |
| NORM | ns-NORM |
| NRL | ns-NRL |
| RL | ns-RL |
| RLPOS | ns-NRP |
| SRCPOFS | ns-SRCPOFS |
| SRCPWR | ns-SRCPWR |
| TS | ns-TAKESWP |

# Equivalent commands

The following table lists scalar analyzer softkeys with their equivalent or similar programming commands.

**Softkeys versus Programming Commands**

| Scalar Analyzer softkey | Corresponding Programming Command |
|---|---|
| 120 dB ON OFF | ns-EOR |
| ANNOT ON OFF | ns_ANNOT |
| ATTENAUTOMAN | ns_AT, ns-AT AUTO |
| ATTEN PORT 1 | ns-EXATN |
| AUTOSCALE | ns_AUTOSC |
| AVERAGE ON | ns-TCA |
| BW MEAS ON OFF | ns-BMT, ns_BWM |
| CALOPN/SHRT | ns-CALR |
| CAL STD DEVICE | ns-CALS |
| CAL THRU | ns-CALT |
| CANCEL | ns-CAN |
| DISPOSE SCALAR | ns_DISPOSE |
| DUAL DSP ON OFF | ns_DDM |
| FFT MEAS | ns_FFT |
| LIMITEST ON | OFF ns-LIMITEST |
| LOWER BW TARGET | ns-LBW |
| LOWER LIMIT | ns-SDLL |

**Softkeys versus Programming Commands (continued)**

| Scalar Analyzer softkey | Corresponding Programming Command |
|---|---|
| NAG S11 ON OFF | ns-MCM, ns-MCT |
| MAG S21 ON OFF | ns-MCM, ns-MCT |
| Marker Convert | ns_MCM |
| MAX RNG ON OFF | ns-URNG |
| MIN RNG ON OFF | ns-LRNG |
| NEGATIVE ON | ns-TCA |
| NORM ON OFF | ns-NORM |
| NORM REF POSN | ns_NRP |
| NUMBER POINTS | ns-TOP |
| POSITIVE ON | ns-TCA |
| REF LEVEL | ns-RL, ns-NRL |
| REFL | ns-REFL |
| SAMPLE ON | ns-TCA |
| SAVE → CAL | ns_RCI, ns_SCI |
| SCALAR PRESET | ns_MP |
| SF MEAS ON OFF | ns-BMT, ns-SFM |
| SRC PWR OFFSET | ns_SRCPOFS |
| SRC PWR ON OFF | ns_SRCOFF, ns-SRCPWR |

**Softkeys versus Programming Commands (continued)**

| Scalar Analyzer softkey | Corresponding Programming Command |
|---|---|
| STORE OPEN | ns-OPEN |
| STORE SHORT | ns_SHRT |
| STORE STD DEV | ns_STD |
| STORE THRU | ns-THRU |
| TABULAR ON OFF | ns-TOD |
| TRANS | ns-TRANS |
| UPPER BW TARGET | ns_UBW |
| UPPER LIMIT | ns-SOUL |
| VSWR ON OFF | ns-MCT |

**Amplitude commands**

| Command Mnemonic | Corresponding Softkey | Description |
|---|---|---|
| ns-AT | ATTEN AUTO MAN | Sets the spectrum analyzer's RF input attenuation. |
| ns_EXATN | ATTEN PORT 1 | Sets HP 85630A Option 001 test set's RF attenuator, |
| ns-NRL | REF LEVEL | Sets normalized reference level. |
| ns_NRP | NORM REFPOSN | Sets normalized reference position. |
| ns-AL | REF LEVEL | Sets the unnormalized reference level. |

**Calibration commands**

| Command Mnemonic | Corresponding Softkey | Description |
|---|---|---|
| ns_CALR | CAL OPN/SHRT | Calibrate open/short (reflection). |
| ns-CALS | CAL STD DEVICE | Calibrate standard device. |
| ns-CALT | CAL THRU | Calibrate thru (transmission]. |
| ns-CAN | CANCEL | Cancels calibration in progress. |
| ns_LRNG | MIN RNG ON OFF | Turns lower calibrated range limit display on or ofl |
| ns_NORM | NORMLIZE ON OFF | Turns display normalization on or off |
| ns-RCI | RECALL → CAL | Recall calibration set internal. |
| ns_SCI | SAVE → CAL | Save calibration set internal. |
| ns_SDLL | LOWER LIMIT | Set standard device lower limit. |
| ns_SDUL | UPPER LIMIT | Set standard device upper limit. |
| ns_OPEN | STORE OPEN | Stores open. |
| ns-SHRT | STORE SHORT | Stores short. |
| ns-STD | STORE STD DEV | Store standard device. |
| ns-THRU | STORE THRU | Stores thru line measurement. |
| ns-URNG | MAX RNG ON OFF | Turns upper calibrated range limit display on or ofl |

**Display control commands**

| Command Mnemonic | Corresponding Softkey | Description |
|---|---|---|
| ns_ANNOT | ANNOTATION ON OFF | Turns annotation on or off. |
| ns-AUTOSC | AUTOSCALE | Autoscales contents of trace A. |
| ns-OOM | DUAL DSP ON OFF | Turns dual display mode on or off. |
| ns_EDR | EXT RNG ON OFF | Turns extended display range on or off. |
| ns-LRNG | MIN RNG ON OFF | Displays lower calibrated range limit lines |
| ns-TCA | AVERAGE 0% | Sets tabular data compression algorithm. |
| ns_TDD | TABULAR ON OFF | Turns tabular data display on or off. |
| ns-TOP | NUMBER POINTS | Sets number of tabular data points. |
| ns_URNG | MAX RNG ON OFF | Displays upper calibrated range limit lines |

**Instrument state commands**

| Command Mnemonic | Corresponding Softkey | Description |
|---|---|---|
| ns_DISPOSE | DISPOSE SCALAR | Disposes the Scalar Analyzer mode |
| ns_MP | PRESET SCALAR | Presets Scalar Analyzer mode. |
| ns_TAKESWP | | Initiates a sweep. |

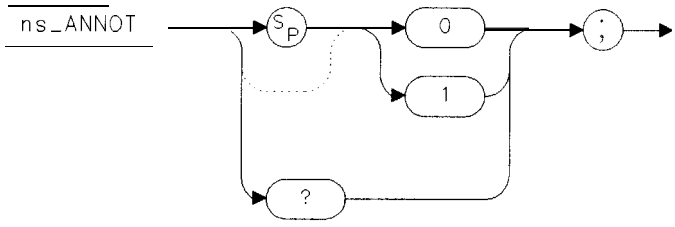
**Measurement mode commands**

| Command Mnemonic | Corresponding Softkey | Description |
|---|---|---|
| ns_BMT | BANDWIDTH ON OFF | Defines bandwidth measurement type. |
| ns_BWM | | Performs bandwidth measurement. |
| nS-FFT | FFT MEAS | Performs fast Fourier transform. |
| ns-LBW | LOWER BY TARGET | Defines lower bandwidth measurement level. |
| hs_LIMITEST | LIMITEST ON OFF | Turns on or off limit line display and testing. |
| hs_MCM | VSWR | Performs marker conversion measurements. |
| ns_MCT | VSWR ON OFF | Oefines marker conversion measurement type. |
| ls-REFL | REFL | Sets reflection measurement mode. |
| ls-SFM | | Performs bandwidth shape factor measurement |
| hs_TRANS | TRANS | Sets transmission measurement mode. |
| hs_UBW | UPPER BW | Defines upper bandwidth measurement level. |

**Source control commands**

| Command Mnemonic | Corresponding Softkey | Description |
|---|---|---|
| ns_SRCOFF | SRC PWR ON OFF | Turns source power [tracking generator] off |
| ns_SRCPOFS | SRC PWR OFFSET | Sets source power offset |
| ns_SRCPWR | SRC PWR ON OFF | Turns on and sets source power |

# ns_ANNOT



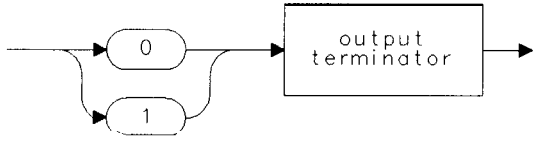

XANNO

The ns_ANNOT command turns screen annotation on (1) or off (0).

Example

```
OUTPUT 718;"ns_ANNOT1;"
```

Query Response



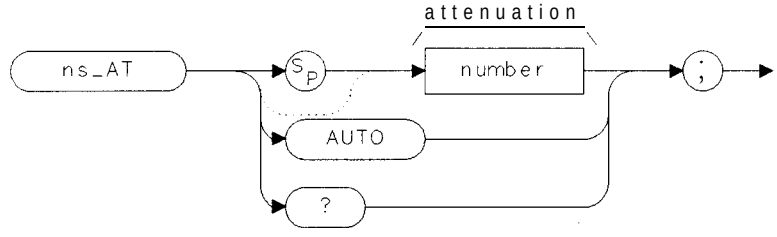

OANNO

The ns_ANNOT command, does not have any effect in the tabular display mode. This command is functionally equivalent to the ANNOTATION ON OFF softkey.

See also

ns_AUTOSC

# ns_AT




XATTE

The ns-AT command sets the spectrum analyzer's RF input attenuation.

The parameters are as follows:

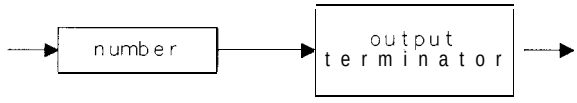
number — 0 to 60 db in 10 dB increments (HP 8590B, HP 8590D, HP 8591A, HP 85913). 0 to 70 db in 10 dB increments (HP 8593A, HP 85933, HP 8594A, HP 85943, HP 8595A, HP 85953, HP 85963).

AUTO — Couples the input attenuator to the reference level or normalized referenced level.

Example

```
OUTPUT 718;"ns_AT10;"
```

Query Response




QATTE

The ns_AT command is functionally equivalent to the **ATTEN** AUTO MAN softkey.

See also

ns-RL, ns-NRL

# ns_AUTOSC

XAUTO

The ns_AUTOSC command performs an immediate autoscale of trace A by adjusting the peak response to the top graticule, and setting the log scale to fill as much of the graticule as possible.

Example

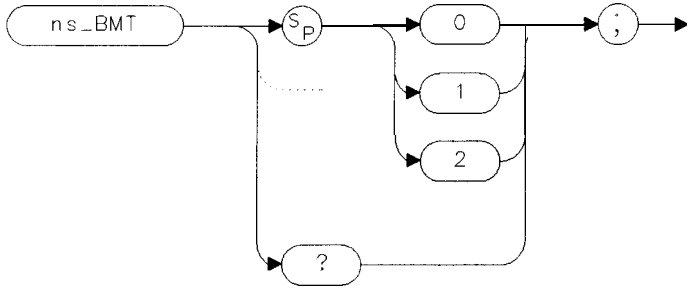
OUTPUT 718;"**ns_AUTOSC;**"

The ns_AUTOSC command is ignored if the dual display mode is currently active. This command is functionally equivalent to the **AUTOSCALE** softkey.

See also

LG, ns_RL, ns-NRL, ns-NRP

# ns_BMT




XBMTK

The ns-BMT command performs indicated marker measurement and displays the data.

The parameters are as follows:

0 No bandwidth measurement.

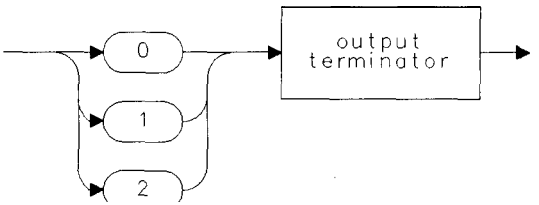
1 Measure and display center frequency, bandwidth, loss, and Q.

2 Measure and display shape factor.

Example

```
OUTPUT718;"ns_BMT 1;"
```

Query Response

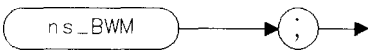



QBMTK

The ns-BMT command continues measurement at the end of every sweep, as long as a marker remains active. The default value is 0 (zero). This command is related to the BANDWIDTH ON OFF and SHAPE FACTOR ON OFF softkeys.

See also ns_BWM, ns-SFM, ns-UBW, and ns_LBW

# ns_BWM




XBWMK

The ns_BWM command performs an immediate center frequency, bandwidth, insertion loss, and Q measurement regardless of the setting of ns_BMT.

Example

```
OUTPUT718;"ns_BWM;"
```

The ns-BWM command's resulting data is both displayed on screen and available remotely. The insertion loss data is only measured if normalization is active (Transmission calibration performed and normalization on).

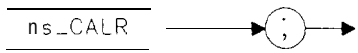
**Scalar Measurement Variables**

| Variable | Stored Value |
|---|---|
| ns_DBQ | Q bandwidth measurement |
| ns-DBW | bandwidth measurement |
| ns_DCF | center frequency bandwidth measurement |
| ns-OIL | insertion loss bandwidth measurement |

See also

ns-UBW, ns_SFM, and ns_CMB.

# ns_CALR




XCALR

The ns-CALR command initializes an open/short (reflection) calibration

Example

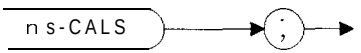
```
OUTPUT 7 18;"ns_CALR;"
```

The ns-CALR command causes the display to prompt the user to connect an open to the appropriate test port. Following the connection, An ns_OPEN (store open) should be immediately performed to store the measured data. This command is functionally equivalent to the CAL OPN/SHRT softkey.

See also

ns_OPEN, ns-SHRT, and ns-CAN.

# ns_CALS




XCALS

The ns-CALS command initializes a standard device calibration

Example

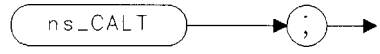
```
OUTPUT 718;"ns_CALS;"
```

The ns-CALS command causes the display to prompt the user to connect a standard device to the appropriate port(s) for measurement and storage. Following the connection, an immediate ns-STD should be performed in order to store the measured data. This command is functionally equivalent to the CAL STD DEVICE softkey.

See also

ns-STD.

# ns_CALT




XCALT

The ns-CALT command initializes a thru (transmission) calibration.

Example

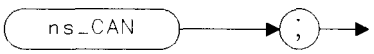
OUTPUT 718; **"ns_CALT;"**

The ns_CALT command causes the display to prompt the user to connect a thru line to the appropriate ports for measurement. Following the connection, an immediate ns_THRU should be performed in order to save the measured data. This command is functionally equivalent to the CAL THRU softkey.

See also

ns-THRU, ns-CAN.

# ns_CAN




XCANK

The ns-CAN command cancels an open/short or thru calibration in process.

The ns_CAN command activates any valid prior calibration. This command is functionally equivalent to the CANCEL softkey.

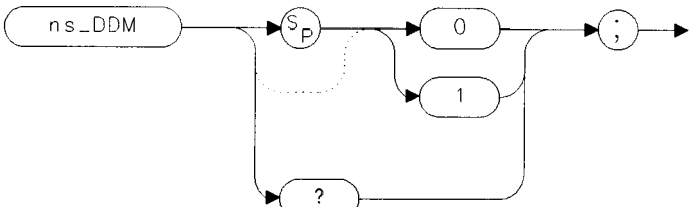
Example

```
OUTPUT718;"ns_CAN;"
```

See also

ns_CALR, ns_CALT, ns_OPEN, ns-SHRT, and ns_THRU.

# ns_DDM




XDDMK

The ns-DDM command immediately turns the dual display mode on or off. The parameters are as follows:

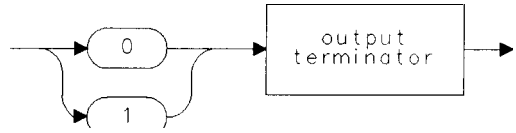
0 Dual display mode off

1 Dual display mode on

Example

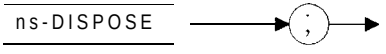
```
OUTPUT 718;"ns_DDM 1;"
```

Query Response




The ns_DDM command requires an HP 85630A scalar transmission/reflection test set. This mode is not allowed in conjunction with the extended display range (ns_EDR) mode. The default value is off. This command is functionally equivalent to the DUAL DSP ON OFF softkey.

# ns_DISPOSE




XDISP

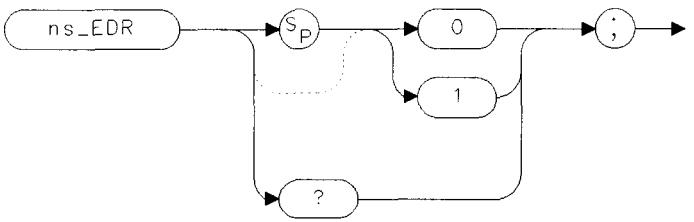
The ns_DISPOSE command immediately purges the scalar personality from the instrument's memory.

Example

```
OUTPUT718;"ns_DISPOSE;"
```

The ns_DISPOSE command is final. The personality is not recoverable, except by re-installing from the HP 85714A personality card. This command is related to the DISPOSE SCALAR softkey.

# ns_EDR




XEDRK

The ns_EDR command immediately turns on or off the extended display mode with 120 dB of measurement range.

The parameters are as follows:

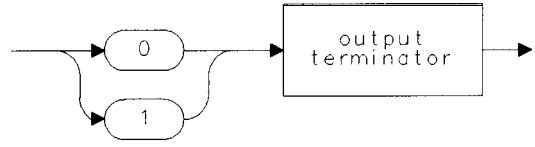
0 Extended display mode off.

1 Extended display mode on

Example

```
OUTPUT718;"ns_EDR 1;"
```

Query Response




QEDRK

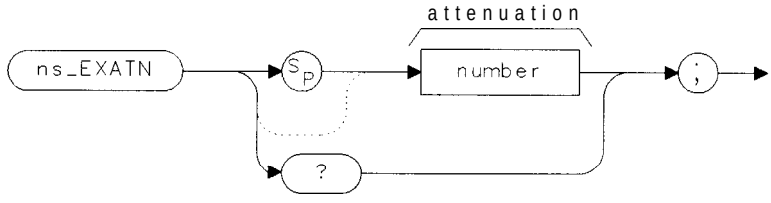
The ns-EDR command, when activating extended display mode, causes two complete sweeps to be taken at different reference levels, and a composite display with up to 120 dB range is constructed. The analyzer will be left in a state that allows marker use or hardcopy (printing or plotting). Continuous sweeps are not allowed, except by repeatedly executing "MOV ns_EDR, 1", or "ns-TAKESWP". When deactivated, the analyzer is returned to the state previous to entering extended display. Extended display is not allowed if the dual display mode is active. The default value is off.

This command is functionally equivalent to the 120 dB ON OFF softkey.

See also

ns-DDM.

# ns_EXATN




XEXAT

The ns-EXATN command sets the input attenuation in the HP 85630 Option 001 test set.

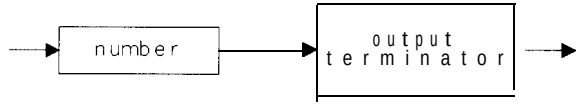
The parameters are as follows:

number — 0 to 70 db in 10 dB increments.

Example

```
OUTPUT 718;"ns_EXATN 10;"
```

Query Response

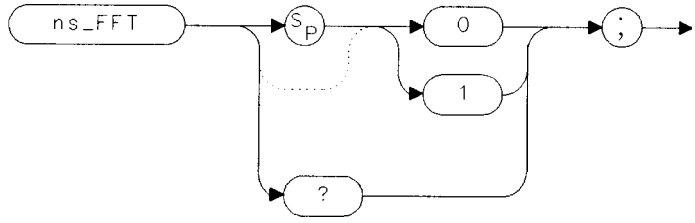



QEXAT

The ns-EXATN command, if the test set is not present, is ignored. This command functionally equivalent to the ATTEN PORT 1 softkey.

See also — ns-SRCPWR, ns_SRCPOFS, and ns_SRCOFF.

# ns_FFT




XFFTK

The ns_FFT command turns the FFT mode off or on. The parameters are as follows:

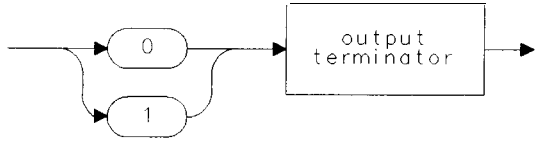
0 FFT mode off.

1 FFT mode on.

Example

```
OUTPUT 718;"ns_FFT 1;"
```

Query Response



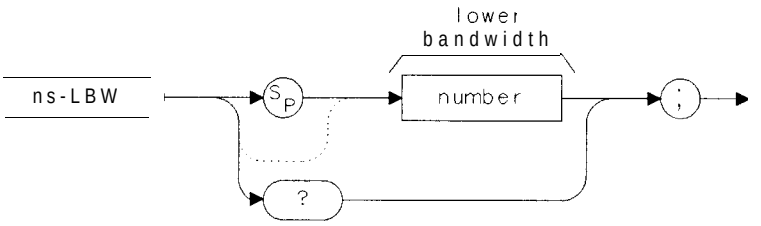

QFFTK

The ns-FFT command, when on, performs an FFT on the current trace and the results displayed on screen. ns-FFT is designed to be used in transforming zero span information into the frequency domain. Performing ns-FFT on a frequency sweep will not provide time-domain results. When turned off, the current measurement mode is restored. The frequency span of the FFT and the sweep time are related. To determine the sweep time to achieve a certain span width, use the following formula:

$$sweep\ time = \frac{200}{frequency\ span}$$

The ns-FFT command is similar to the spectrum analyzer's FFT command with the exception the ns-FFT always applies a FLATTOP filter window to the fast Fourier transform. (Refer to the FFT command in the spectrum analyzer's programming manual for more information.) The spectrum analyzer's TWNDOW command cannot be used to change the window to UNIFORM or HANNING. The FLATTOP filter simulates a passband that represents a give-and-take between amplitude uncertainty, sensitivity, and frequency resolution.

# ns_LBW




XLBWK

The ns_LBW command defines the lower (wider) target bandwidth for a shape factor measurement.

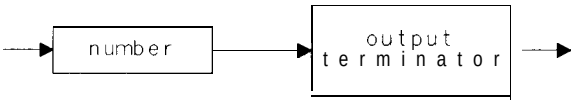
The parameters are as follows:

number — Negative integer defining bandwidth in dB.

Example

```
OUTPUT 718; "ns_LBW -6; "
```

Query Response

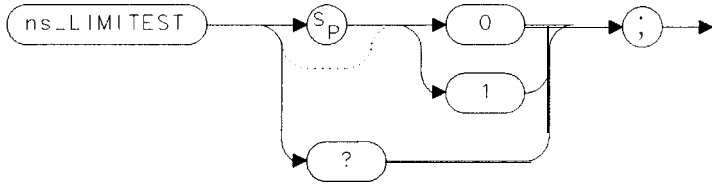



QLBWK

The ns_LBW command's default value is -60. The bandwidth shape factor is defined as the ratio (ns-UBW/ns-LBW). This command is functionally equivalent to the LOWER BW TARGET softkey.

See also — ns-BMT, ns-SFM, and ns-UBW.

# ns_LIMITEST




XLIMI

The ns-LIMITEST command turns the limit-line display and testing on and Off.

The parameters are as follows:

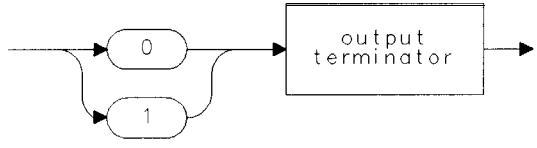
0 Turns limit-line display and testing off.

1 Turns limit-line display and testing on.

Example

```
OUTPUT 718 ;"ns_LIMITEST 1;"
```

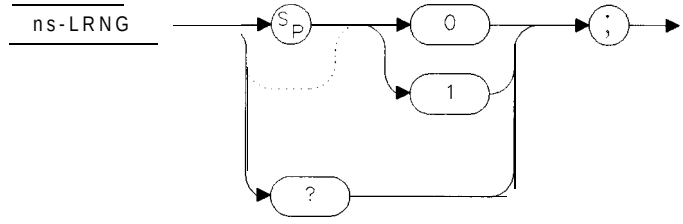
Query Response




OLIMI

The ns-LIMITEST command assumes limit lines are loaded and valid. (To ensure proper placement of the limit line, be sure to set the normalized reference position to eight before loading the limit line.) The default for this command is off. This command is functionally equivalent to the LIMITEST ON OFF softkey.

# ns_LRNG




The ns-LRNG command draws and displays a trace marking the lower calibrated display limit.

The parameters are as follows:

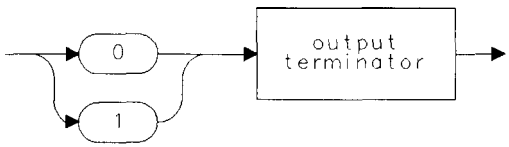
0 Calibrated display limits off.

1 Calibrated display limits on.

Example

```
OUTPUT 718;"ns_LRNG 1;"
```

Query Response




QLRNG

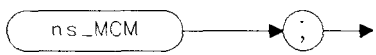
The ns_LRNG command is not available with the dual display or extended display range mode active. The default is off. If this level is below the bottom graticule, it may not be visible unless the display is re-scaled (Log dB/division).

This command is functionally equivalent to the MIN RNG ON OFF softkey.

See also

ns-URNG.

# ns_MCM




XMCMK

The ns-MCM command immediately performs all appropriate marker conversions and displays the results.

Example

OUTPUT 718;"ns_MCM;"

The ns-MCM command resulting data is available remotely. A valid thru (transmission) calibration is necessary for MAG S21 conversion, as a valid open/short (reflection) calibration is necessary for MAG S11 or VSWR conversion to be performed.

This command is related to the MAG S21 ON OFF , MAG S11 ON OFF and VSWR ON OFF softkeys.

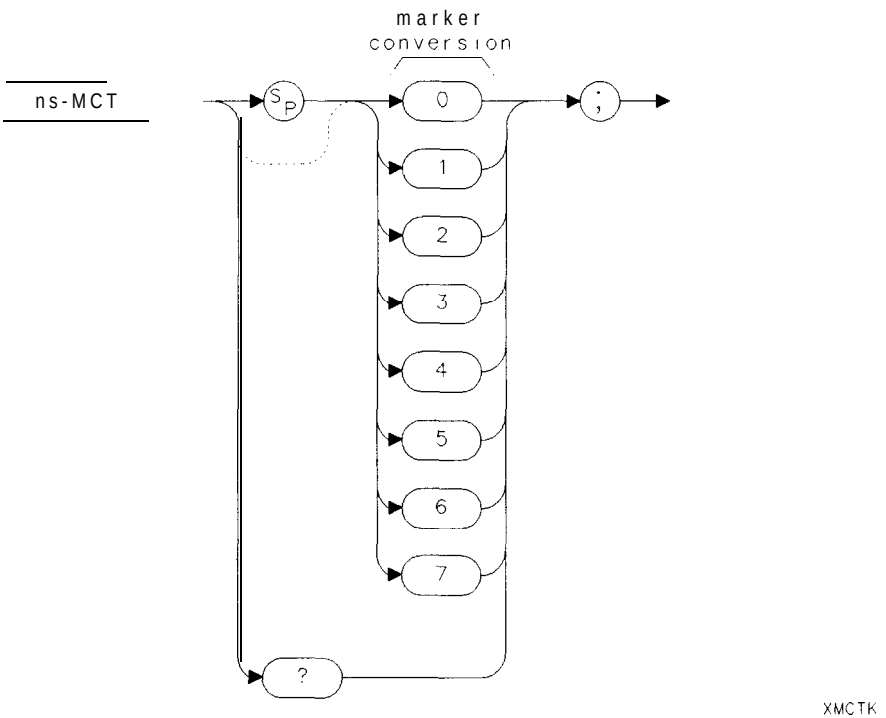
**Scalar Measurement Variables**

| Variable | Stored Value |
|---|---|
| ns_MRC | reflection coefficient |
| ns_MTC | transmission coefficient |
| ns_VSWR | VSWR |

See also

ns-MCT.

# ns_MCT




The ns_MCT command defines the type of amplitude marker conversions to be performed.

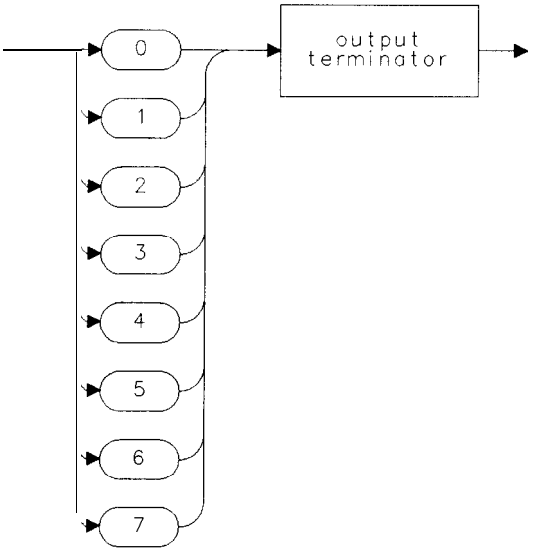
The parameters are as follows:

| | |
|---|---|
| 0 | All conversions off. |
| 1 | Convert to MAG S11 (Magnitude of reflection co-efficient). |
| 2 | Convert to VSWR (Voltage standing- wave ratio). |
| 3 | Convert marker to MAG S1 1 and VSWR. |
| 4 | Convert to MAG S21 (Magnitude of reflection co-efficient). |
| 5 | Convert to MAG S2 1, MAG S1 1 (Dual display only). |
| 6 | Convert to MAG S21, VSWR (Dual display only). |
| 7 | Convert to MAG S21, MAG S 11, VSWR (Dual display only). |

Example

```
OUTPUT 718;"ns_MCT1;"
```

Query Response



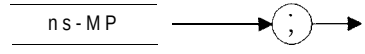

QMCTK

The ns_MCT command marker conversions are performed only during valid measurement conditions and calibrations as outlined for the ns_MCM command. The appropriate conversions will be made at the end of each sweep, provided the marker is turned on (active). The default value is 0 (zero, all conversions off).

This command is related to the MAG S11 ON OFF , VSWR ON OFF , and MAG S21 ON OFF softkeys.

See also ns_MCM

# ns_MP




XMPKK

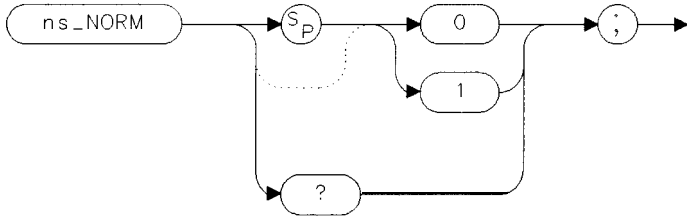
The ns_MP command presets the spectrum analyzer and scalar measurements personality to a known state.

Example

```
OUTPUT 718;"ns_MP;"
```

The ns_MP command should be used in place of a spectrum analyzer IP. This is because IP exits the scalar measurements mode. This command is functionally equivalent to the SCALAR PRESET softkey.

# ns_NORM




XNORM

The ns-NORM command turns normalization off or on. The parameters are as follows:

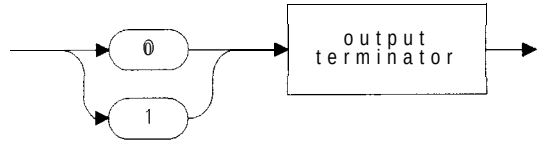
0 Normalization off.

1 Normalization on.

Example

```
OUTPUT 7 18;"ns_NORM 1;"    Turn normalization on.
```

Query Response




QNORM

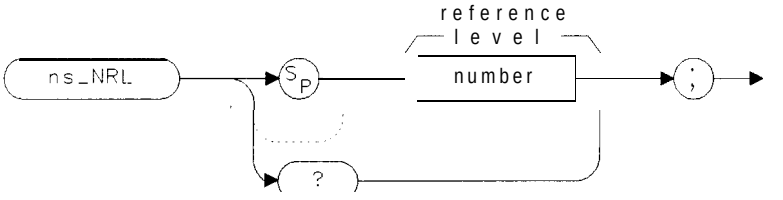
The ns-NORM command cannot be used to turn on normalization if a valid calibration has not been completed or recalled. Normalization is automatically turned on at the completion of a calibration (open/short or thru). Note that normalization is independent between the two main measurement modes (transmission or reflection), and will be recalled appropriately when shifting between the modes. The default for normalization is off.

This command is functionally equivalent to the NORM ON OFF softkey.

See also

ns-CALT and ns_CALR.

# ns_NRL




XNRLK

The ns-NRL command changes the reference level after normalization.

The parameters are as follows:

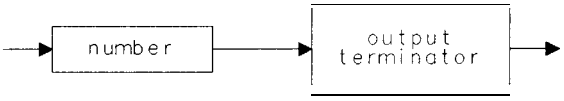
number

Valid number is -200 to 200 dB. Range is dependent on the initial reference level setting when the calibration is performed.

Example

```
OUTPUT 718;"ns_NRL 10;"
```

Query Response




QNRLK

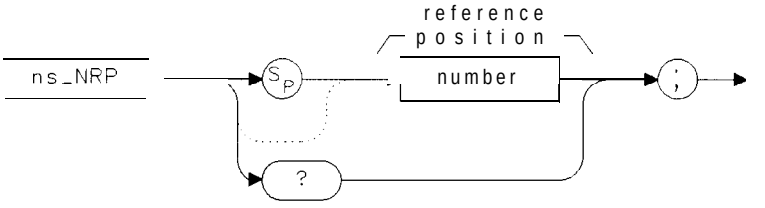
The ns-NRL command's default parameter is 0 dB. After a calibration is complete, the reference level and markers change from an absolute power (dBm) to relative power (dB) readout. The normalized reference level can be set or changed remotely if normalization is turned off, however it will not affect the instrument state until normalization is turned on.

This command is functionally equivalent to the REF LEVEL softkey when normalization is on.

See also

ns-NORM and ns_NRP.

# ns_NRP




The ns_NRP command sets the reference position on screen.

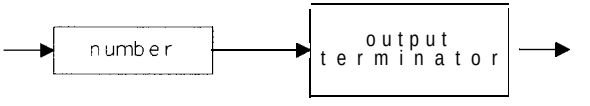
The parameters are as follows:

number — Integer from 0 and 8.

Example

```
OUTPUT 7 18;"ns_NRP 4;"   Set position to middle screen.
```

Query Response



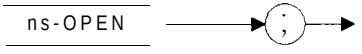

QNRPK

The ns-NRP command is only valid if normalization is turned on. The valid range is from 0 (zero, or bottom of graticule) to 8 (eight, or top of graticule). The default value is 8, or top of the graticule.

This command is functionally equivalent to the NORM REF POSN softkey.

See also — ns_NRL and ns-NORM.

# ns_OPEN




XOPEN

The ns_OPEN command stores the reflection response on an open circuit

Example

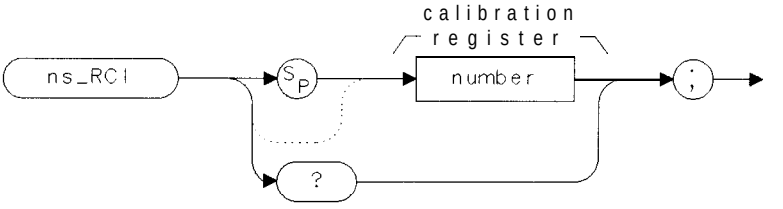
```
OUTPUT 718;"ns_OPEN;"
```

The ns-OPEN command causes the display to prompt the operator to connect a short circuit to the reflection measurement port in order to complete a reflection calibration. This command is functionally equivalent to the STORE OPEN softkey.

See also

ns_CALR, ns-SHRT, ns_NORM

# ns_RCI




XRCIK

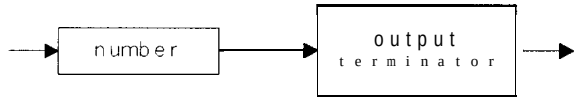
The ns-RCI command recalls a calibration set from internal memory The parameters are as follows:

number — Integer value for valid register.

Example

```
OUTPUT 718;"ns_RCI1;"
```

Query Response

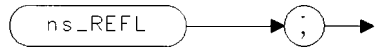



QRCTK

The ns_RCI command recalls a complete set of transmission and reflection calibration and instrument states are recalled. Normalization is restored, if valid when stored. The valid range of register numbers is from 0 (zero) to a maximum dependent on the total number of trace storage memory available. Register zero is a special case, which recalls the instrument state that the current cal is valid at, or the frequency span and reference level settings which the instrument is currently calibrated for. This command is functionally equivalent to the SAVE → CAL softkey.

See also ns_SCI,TRCMEM

# ns_REFL




XREFL

The ns_REFL command sets the reflection measurement mode.

Example

OUTPUT 718;"**ns_REFL;**"

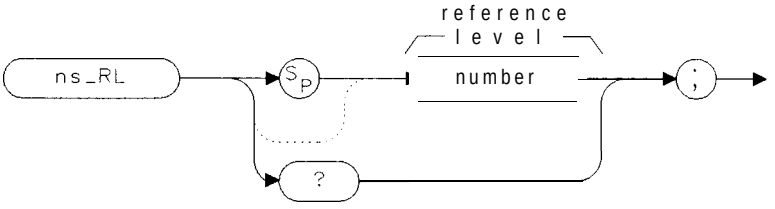
The ns_REFL command restores all amplitude and frequency parameters to the values associated with the reflection measurement, and normalization is turned on or off appropriately. If the instrument is in the transmission mode prior to executing this command, all frequency, amplitude and normalization parameters are stored for future return to that mode.

This command functionally equivalent to the REFL softkey.

See also

ns_TRANS and ns_CALR

# ns_RL




XRLKK

The ns-RL command sets the reference level before normalization.

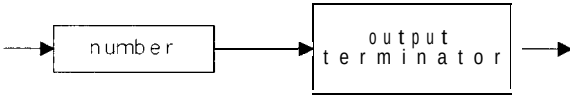
The parameters are as follows:

number — Real number expressed in integer, decimal, or exponential form.

Example

```
OUTPUT 718;"ns_RL5DB;"   Offsets normalized reference level 5 dB.
```

Query Response



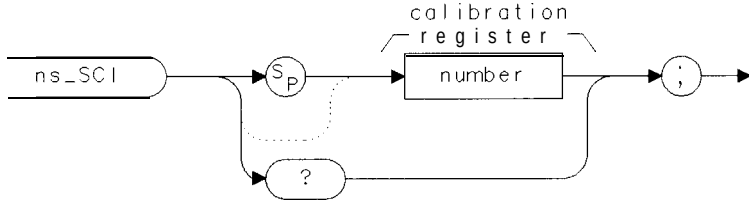

QRLKK

The ns_RL command's range is hard limited dependent on the instrument in use, typically – 140 to + 50 or + 60 dBm. If executed after normalization is turned on, it will have no affect until normalization is turned off. The default value is 0 dBm.

This command is functionally equivalent to the **REF** LEVEL softkey when normalization is turned off.

See also — ns_LG, ns_NRL, ns-NORM, and ns-NRP

# ns_SCI




XSCIK

The ns_SCI command stores the current calibration set and instrument state for both transmission and reflection measurements in the register specified.

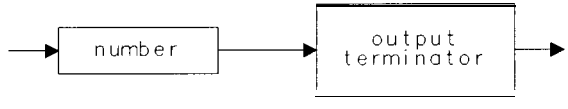
The parameters are as follows:

number — Integer value for valid register.

Example

```
OUTPUT 718;"ns_SCI 1;"
```

Query Response

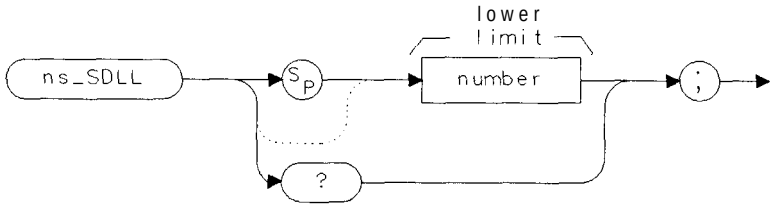



QSCIK

The ns_SCI command stores the frequency and amplitude parameters for each measurement mode independently. The valid range of registers is from 1 (one) to a maximum dependent on the total number of available trace registers. This command is functionally equivalent to the SAVE → CAL softkey.

See also — ns-RCI and TRCMEM.

# ns_SDLL




XSDLL

The ns-SDLL command sets the lower limit for a standard device calibration and limit test.

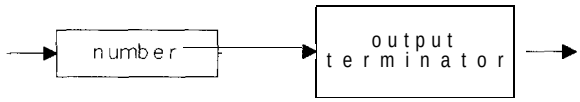
The parameters are as follows:

number — Negative real number between 0 to 200 dB inclusive.

Example

```
OUTPUT 718; "ns_SDLL -60.0; "
```

Query Response

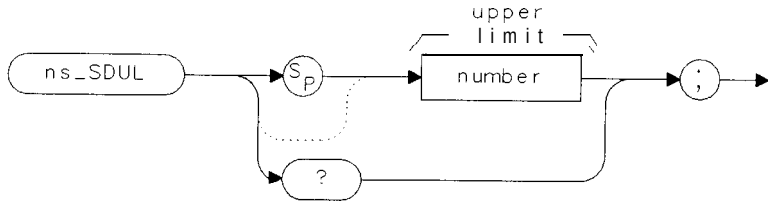



QSDLL

The ns-SDLL command can set the lower limit before or after performing a standard device calibration. The lower limit is added to the standard device response and then transferred to the lower limit line. The default value is -3 dB. This command is functionally equivalent to the LOWER LIMIT softkey.

See also — ns-SDUL and ns-STD

# ns_SDUL




XSDUL

The ns_SDUL command sets the upper limit for a standard device calibration and limit test.

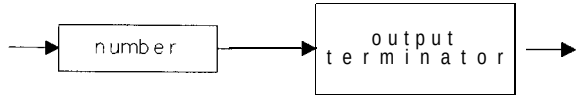
The parameters are as follows:

number — Positive real number between 0 to 200 dB, inclusive.

Example

```
OUTPUT 718;"ns_SDUL 10.0;"
```

Query Response

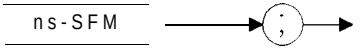



QSDUL

The ns_SDUL command can set the upper limit before or after performing a standard device calibration. The upper limit is added to the standard device response and then transferred to the upper limit line. The default value is +3 dB. This command is functionally equivalent to the UPPER LIMIT softkey.

See also — ns_SDLL, ns_STD

# ns_SFM




XSFMK

The ns-SFM command immediately performs a single bandwidth shape factor measurement.

Example

```
OUTPUT 7 18;"ns_SFM;"
```

The ns_SFM measurement results are displayed on screen as well as being available remotely. The shape factor is defined as the ratio ns_LBW/ns_UBW.

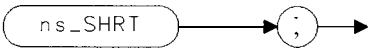
**Scalar Measurement Variables**

| Variable | Stored Value |
|---|---|
| ns_DSF | bandwidth shape factor |

See also

ns-UBW, ns-LBW, ns-BMF, and ns-CMB

# ns_SHRT




XSHRT

The ns-SHRT command stores the reflection response of a short circuit.

Example

```
OUTPUT 718;"ns_SHRT;"
```

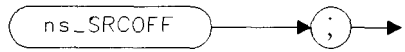
The ns_SHRT command causes the scalar measurement personality to perform an average with the previously stored open circuit response, then stores the results for reflection normalization purposes. Normalization is turned on.

This command is functionally equivalent to the STORE SHORT softkey.

See also

ns_CALR, ns-OPEN, ns-NORM

# ns_SRCOFF




XCOFF

The ns_SRCOFF command immediately turns the source RF output power off.

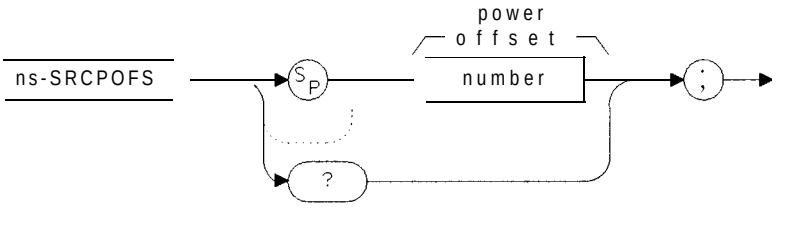
Example

```
OUTPUT 718;"ns_SRCOFF;"
```

See also

ns_SRCPWR

# ns_SRCPOFS




XCPOF

The ns_SRCPOFS command allows the displayed source output power to be offset from the actual source output power.

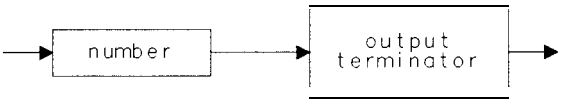
The parameters are as follows:

number — Real number expressed in integer, decimal, or exponential form.

Example

```
OUTPUT 718;"ns_SRCPOFS 5;"
```

Query Response

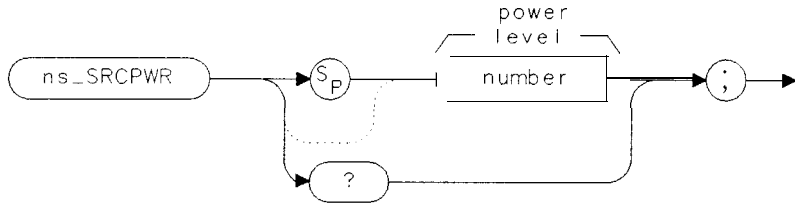



QCPOF

The ns-SRCPOFS command adds the offset to the current source level and is displayed. Once set, the offset is subtracted from any incoming source power level adjustment before setting the actual output power level. The default is 0 dB (no offset).

This command is functionally equivalent to the SRC PWR OFFSET softkey.

# ns_SRCPWR




XCPWR

The ns-SRCPWR command sets the source output power to the level specified.

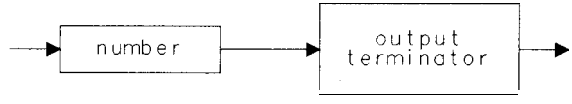
The parameters are as follows:

number — Real number expressed in integer, decimal, or exponential form.

Example

```
OUTPUT 718; "ns_SRCPWR -5.5;"    Source power to -5.5 dBm.
```

Query Response

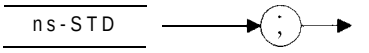



The ns_SRCPWR command turns the source on if the source is turned off. The range is dependent on the instrument, and is hard limited accordingly,

This command is functionally equivalent to the SRC PWR ON OFF softkey.

See also — ns_SRCOFF and ns-SRCPOFS.

# ns_STD




XSTDK

The ns_STD command stores the response of a standard device.

Example

```
OUTPUT718;"ns_STD;"
```

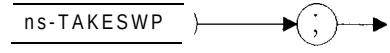
The ns-STD command causes the scalar measurement personality to add the upper and lower test limits, and transfer the results to upper and lower limit line traces. Limit test is then activated. Note that the stored limit lines are traces, and therefore cannot be edited as normal limit lines can.

This command is functionally equivalent to the STORE STD DEV softkey.

See also

ns-CALS, ns_SDLL, ns-SDUL, and LIMITLINES.

# ns_TAKESWP




XTAKE

The ns-TAKESWP command replaces the instrument's TS command.

Example

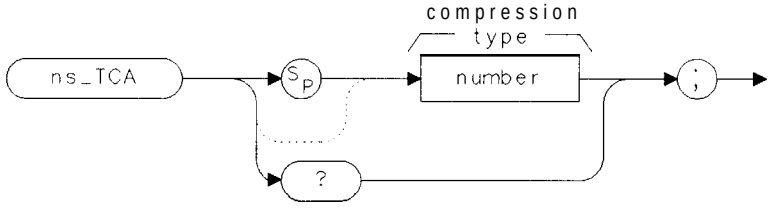
```
OUTPUT718;"ns_TAKESWP;"
```

The ns-TAKESWP command properly completes sweeps if the extended display range (ns-EDR) or dual display mode (ns-DDM) are active. If these modes are not active, a normal TS is generated.

See also

ns-DDM, ns-EDR

# ns_TCA




The ns_TCA command sets the compression algorithm to be used when compressing the tabular data trace.

The parameters are as follows:

Average — The average of the points within an interval are used. Equivalent to the AVERAGE ON softkey.

Normal — The compressed value of the interval is computed using a Rosenfell algorithm. If the data within the interval is continuously rising, the compressed value taken is the maximum (last) value within the interval. If the data within the interval is continuously falling, the compressed value taken is the minimum (last) value within the interval. If the data within the average is not continuously rising OR falling, the compressed value will alternate between the maximum and minimum value detected within the intervals. Equivalent to the NORMAL ON softkey.

Negative — The compressed value taken is the lowest value from the interval. Equivalent to the NEGATIVE ON softkey.

Positive — The compressed value taken is the highest value from within the interval. Equivalent to the POSITIVE ON softkey.

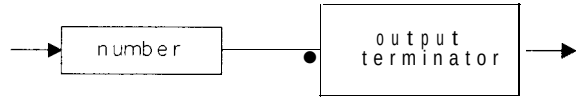
Sample

The compressed value taken is the last value from the interval. Equivalent to the SAMPLE ON softkey.

Example

```
OUTPUT 718;"ns_TCA 1;"
```

Query Response



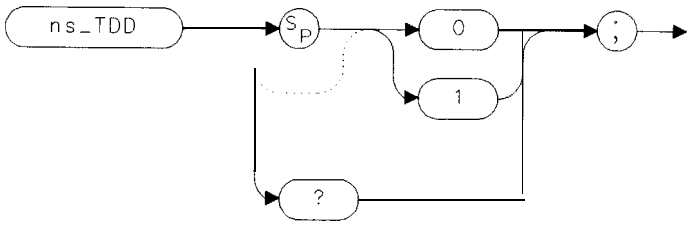

QTCAK

The ns_TCA command changes the compression type from the default of sample. As the number of displayed tabular data points can be fewer than the actual data trace length (401 points), the compression algorithm defines how the data is compressed.

See also

ns-TDD and ns-TDP.

# ns_TDD




XTDDK

The ns_TDD command turns the tabular data display off or on. The parameters are as follows:

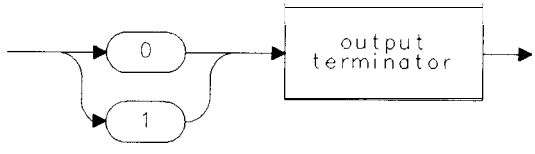
0 Tabular data display off.

1 Tabular data display on.

Example

```
OUTPUT 718;"ns_TDD 1;"
```

Query Response



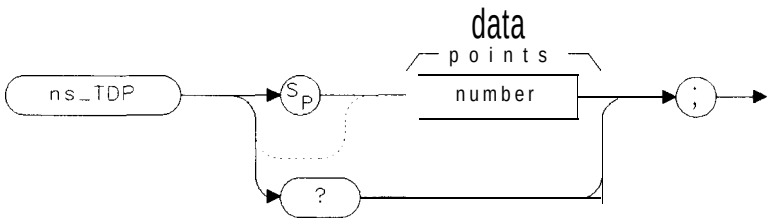

QTDDK

The ns-TDD command is equivalent to the TABULAR ON OFF softkey. When tabular data is activated, a sweep is taken and the resulting data compressed as per the setting of ns_TCA. After compression, the data is displayed on screen. Continuous sweeps are not allowed except by repeatedly executing MOV `ns_TDD,1` or `ns_TAKESWP`.

See also

ns_TCA, ns_TDP

# ns_TDP




XTDPK

The ns_TDP command sets the number of points available for a tabular data display.

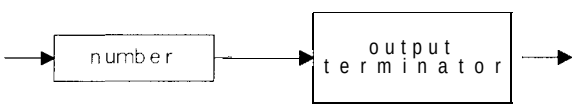
The parameters are as follows:

number — Integer from 3 through 401.

Example

```
OUTPUT 718;"ns_TDP 256;"
```

Query Response




QTDPK

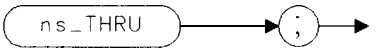
The ns_TDP command can be used to change the default of 401 trace points. The actual data trace (401 points) is compressed, via the algorithm determined by ns-TCA, into a trace of length ns-TDP. Only 18 points can be displayed simultaneously on screen, but the whole trace (ns-TDP in length) is output to a printer if the copy key is pressed and tabular data display is turned on.

This command is functionally equivalent to the NUMBER POINTS softkey.

See also

ns-TCA and ns_TDD.

# ns_THRU




XTHRU

The ns_THRU command stores the thru transmission measurement for normalization purposes.

Example

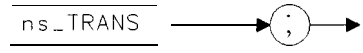
OUTPUT 718;"**ns_THRU;**"

The ns_THRU command causes normalization to be turned on. This command is functionally equivalent to the STORE THRU softkey.

See also

ns-CALT, ns-NORM

# ns_TRANS




XTRAN

The ns-TRANS command sets the transmission measurement mode.

Example

```
OUTPUT718;"ns_TRANS;"
```

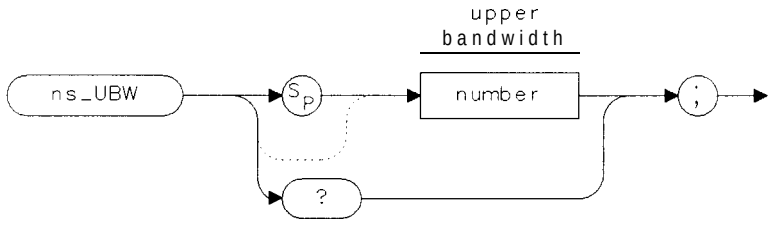
The ns_TRANS command restores all amplitude and frequency parameters to the values associated with the transmission measurement, and normalization is turned on or off appropriately. If the instrument is in the reflection mode prior to executing this command, all frequency, amplitude and normalization parameters are stored for future return to that mode.

This command functionally equivalent to the TRANS softkey.

See also

ns-REFL and ns_CALT

# ns_UBW




XUBWK

The ns_UBW command sets the target bandwidth used for either a bandwidth measurement or shape factor measurement (upper bandwidth).

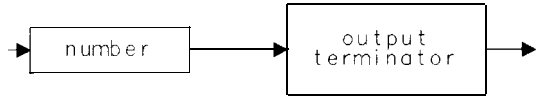
The parameters are as follows:

number — Negative real.

Example

```
OUTPUT 718;"ns_UBW-6;"
```

Query Response

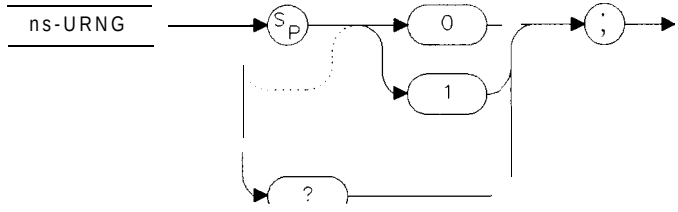



QUBWK

The ns-UBW command is functionally equivalent to the UPPER BW softkey. The default bandwidth is -3.

See also — ns-BMT, ns-BWM, ns-SFM, and ns-LBW.

# ns_URNG




XURNG

The ns-URNG command draws and displays a trace marking the upper calibrated display limit.

The parameters are as follows:

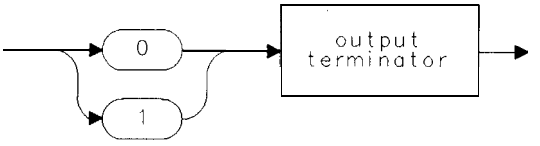
0 Calibrated display limit off.

1 Calibrated display limit on.

Example

```
OUTPUT 718;"ns_URNG1;"
```

Query Response




QURNG

The ns_URNG command is not available with the dual display or extended display range mode active. If this level is above the top graticule, it may not be visible unless the display is re-scaled (Log dB/division) or the reference level adjusted. The default is off.

This command is functionally equivalent to the MAX RNG ON OFF softkey.

See also ns_LRNG

# Characteristics

Characteristics provide information about non-warranted instrument performance in the form of nominal values. These values are bases on estimated worst-case system performance. Characteristics are not specifications. The characteristics in this section are for systems which include the following:

- a spectrum analyzer (Option 010)
- an HP 85630A scalar transmission/reflection test set
- an HP 85714A scalar measurements personality

**HP 8590 A and B Series**
**System Characteristics (1 of 8)**

| Configuration: HP 85714A, HP 85630A, and spectrum analyzer with tracking generator option | PORT 1 Source Match | | PORT 2 Input Match† |
|---|---|---|---|
| | Attenuation (where applicable) | | |
| | test set: 0 dB source: 0 dB | test set: 10 dB or source: 10 dB | |
| HP 8590B Opt. 003 | | | |
| 0.3 - 1200 MHz | 16.3 dB | 18.2 dB | 15.3 dB |
| 1200 - 1800 MHz | 15.7 dB | 17.5 dB | 12.0 dB |
| HP 8591A | | | |
| 0.3 - 1200 MHz | 16.3 dB | 18.2 dB | 15.3 dB |
| 1200 - 1800 MHz | 15.7 dB | 17.5 dB | 12.0 dB |
| HP 8593A | | | |
| 0.3 . 1200 MHz | 16.9 dB | 19.2 dB | 14.6 dB |
| 1200 - 2900 MHz | 16.3 dB | 18.5 dB | 11.8 dB |
| HP 8594A* | | | |
| 0.3 - 1200 MHz | 16.9 dB | 19.2 dB | 15.3 dB |
| 1200 - 2900 MHz | 16.3 dB | 18.5 dB | 12.0 dB |
| HP 8595A* | | | |
| 0.3 - 1200 MHz | 16.9 dB | 19.2 dB | 15.3 dB |
| 1200 - 2900 MHz | 16.3 dB | 18.5 dB | 12.0 dB |

* DC coupled signal analyzer input

† 10 dB signal analyzer input attenuation

**HP 8590 D and E Series**
**System Characteristics (2 of 8)**

| Configuration: HP 85714A, HP 85630A, and spectrum analyzer with tracking generator option | PORT 1 Source Match | | | PORT 2 Input Match† |
|---|---|---|---|---|
| | Attenuation (where applicable) | | | |
| | test set: 0 dB source: 0 dB | test set: 10 dB source: 0 dB | test set: 0 dB source: 10 dB | |
| HP 85900 Opt. 003 | | | | |
| 0.3 - 1200 MHz | 16.3 dB | 20.9 dB | N/A | 15.3 dB |
| 1200 - 1800 MHz | 15.7 dB | 19.9 dB | N/A | 12.0 dB |
| HP 8590L Opt. 003 | | | | |
| 0.3 - 1200 MHz | 16.3 dB | 20.9 dB | N/A | 15.3 dB |
| 1200 . 1800 MHz | 15.7 dB | 19.9 dB | N/A | 12.0 dB |
| HP 8591E | | | | |
| 0.3 - 1200 MHz | 16.3 dB | 20.9 dB | 18.2 dB | 15.3 dB |
| 1200 - 1800 MHz | 15.7 dB | 19.9 dB | 17.5 dB | 12.0 dB |
| HP 8593E | | | | |
| 0.3 - 1200 MHz | 15.3 dB | 20.7 dB | 18.5 dB‡ | 14.6 dB |
| 1200 - 2900 MHz | 14.7 dB | 19.8 dB | 17.7 dB | 11.8 dB |
| HP 8594E* | | | | |
| 0.3 - 1200 MHz | 15.3 dB | 20.7 dB | 18.5 dB‡ | 15.3 dB |
| 1200 - 2900 MHz | 14.7 dB | 19.8 dB | 17.7 dB | 12.0 dB |

*** DC coupled signal analyzer input**

**† 10 dB signal analyzer input attenuation**

**$ Source attenuation = 8 dB.**

**HP 8590 D and E Series**
**System Characteristics (2 of 8 continued)**

| Configuration: HP 85714A, HP 85630A, and spectrum analyzer with tracking generator option | PORT 1 Source Match | | | PORT 2 Input Match† |
|---|---|---|---|---|
| | Attenuation (where applicable) | | | |
| | test set: 0 dB source: 0 dB | test set: 10 dB source: 0 dB | test set: 0 dB source: 10 dB | |
| HP 8595E* | | | | |
| 0.3 1200 MHz | 15.3 dB | 20.7 dB | 16.5 dB‡ | 15.3 dB |
| 1200 - 2900 MHz | 14.7 dB | 19.8 dB | 17.7 dB | 12.0 dB |
| HP 8596E* | | | | |
| 0.3 1200 MHz | 15.3 dB | 20.7 dB | 16.5 dB‡ | 15.3 dB |
| 1200 - 2900 MHz | 14.7 dB | 19.8 dB | 17.7 dB | 12.0 dB |

* DC coupled signal analyzer input

† 10 dB signal analyzer input attenuation

‡ Source attenuation = 8 dB.

**HP 9590 A and B Series**
**System Characteristics (3 of 8)**

| Configuration: HP 85714A, HP 85630A, and spectrum analyzer with tracking generator option | Dynamic Range | Test Set Isolation |
|---|---|---|
| HP 8590B Opt. 003 | | |
| 0.3 - 1200 MHz | 86 dB† | 100 dB |
| 1200 - 1800 MHz | 83 dB† | 97 dB |
| 0.1 - 1800 MHz | 106 dB** | — |
| HP 8591A | | |
| 0.3 - 1200 MHz | 86 dB† | 100 dB |
| 1200 - 1800 MHz | 83 dB† | 97 dB |
| 0.1 - 1800 MHz | 106 dB** | — |
| HP 8593A | | |
| 0.3 - 1200 MHz | 95 dB‡ | 100 dB |
| 1200 - 2900 MHz | 94 dB‡ | 97 dB |
| 0.3 - 2900 MHz | 113 dB** | — |
| HP 8594A* | | |
| 0.3 - 1200 MHz | 91 dB‡# | 100 dB |
| 1200 - 2900 MHz | 95 dB‡ | 97 dB |
| 0.3 - 2900 MHz | 113 dB** | — |
| HP 8595A* | | |
| 0.3 - 1200 MHz | 94 dB‡ | 100 dB |
| 1200 - 2900 MHz | 94 dB‡ | 97 dB |
| 0.3 . 2900 MHz | 113 dB** | — |

* DC coupled signal analyzer input
† 10 kHz resolution bandwidth
‡ 1 kHz resolution bandwidth
# displayed average noise dominates 0.4 - 5.0 MHz
** This range available when bypassing the HP 85630A and connecting DUT between tracking generator output and spectrum analyzer input.

**HP 8590 D and E Series**
**System Characteristics (4 of 8)**

| Configuration: HP 85714A, HP 85630A, and spectrum analyzer with tracking generator option | Dynamic Range | Test Set Isolation |
|---|---|---|
| HP 85900 Opt. 003 | | |
| 0.3 - 1200 MHz | 86 dB† | 100 dB |
| 1200 . 1800 MHz | 83 dB† | 97 dB |
| 0.1 - 1800 MHz | 106 dB** | |
| HP 8590L Opt. 003 | | |
| 0.3 - 1200 MHz | 86 dB† | 100 dB |
| 1200 - 1800 MHz | 83 dB† | 97 dB |
| 0.1 - 1800 MHz | 106 dB** | — |
| HP 8591E | | |
| 0.3 - 1200 MHz | 86 dB† | 100 dB |
| 1200 - 1800 MHz | 83 dB† | 97 dB |
| 0.1 - 1800 MHz | 106 dB** | — |
| HP 8593E | | |
| 0.3 - 1200 MHz | 93 dB‡ | 100 dB |
| 1200 - 2900 MHz | 92 dB‡ | 97 dB |
| 0.3 - 2900 MHz | 111 dB** | — |
| HP 8594E* | | |
| 0.3 . 1200 MHz | 89 dB‡# | 100 dB |
| 1200 - 2900 MHz | 93 dB‡ | 97 dB |
| 0.3 . 2900 MHz | 111 dB** | — |

* DC coupled signal analyzer input
† 10 kHz resolution bandwidth
‡ 1 kHz resolution bandwidth
# displayed average noise dominates 0.4 - 5.0 MHz
** This range available when bypassing the HP 85630A and connecting DUT between tracking generator output and spectrum analyzer input.

**HP 8590 D and E Series**
**System Characteristics (4 of 8 continued)**

| Configuration: HP 85714A, HP 85630A, and spectrum analyzer with tracking generator option | Dynamic Range | Test Set Isolation |
|---|---|---|
| HP 8595E* | | |
| 0.3 - 1200 MHz | 92 dB‡ | 100 dB |
| 1200 - 2900 MHz | 92 dB‡ | 97 dB |
| 0.3 - 2900 MHz | 111 dB** | – |
| HP 8596E* | | |
| 0.3 - 1200 MHz | 92 dB‡ | 100 dB |
| 1200 - 2900 MHz | 92 dB‡ | 97 dB |
| 0.3 - 2900 MHz | 111 dB** | – |

∗ DC coupled signal analyzer input
† 10 kHz resolution bandwidth
‡ 1 kHz resolution bandwidth
#displayed average noise dominates 0.4 - 5.0 MHz
∗∗ This range available when bypassing the HP 85630A and connecting DUT between tracking generator output and spectrum analyzer input.

**System Characteristics (5 of 8)**

| Configuration: HP 85714A, HP 85630A, and spectrum analyzer with tracking generator option | frequency Readout Accuracy (Start, Stop, Center, Marker) |
|---|---|
| **HP 8590B Opt. 003, HP 8590D Opt. 003** | |
| all frequency spans | ±(5 MHz + 1% of frequency span) |
| **HP 8591A, HP 8693A, HP 8594A, HP 8595A** | |
| freq. span ≤ 10 MHz | ±(freq. readout x freq. reference error* + 3.0% of span + 20% of RBW + 100 Hz) |
| freq. span > 10 MHz | ±(freq. readout x freq. reference error* + 3.0% of span + 20% of RBW) |
| **HP 8590D Opt. 013, HP 65901, HP 8593E, HP 8594E, HP 8595E, HP 8596E** | |
| freq. span ≤ 10 MHz | ±(freq. readout x freq. reference error* + span accuracy + 1.0% of span + 20% of RBW + 100 Hz)‡ |
| * Refer to spectrum analyzer specification. | |
| $ See drift under stability in spectrum analyzer characteristics | |

**System Characteristics (6 of 8)**

| Configuration: HP 85714A, HP 85630A, and spectrum analyzer with tracking generator option | Sweeptime (10 kHz resolution bandwidth 10 kHz video bandwidth) |
|---|---|
| HP 8590B Opt. 003, HP 85900 Opt. 003 | 50 ms/401 points |
| HP 8590L, HP 8591A, HP 8591E | 50 ms/401 points |
| HP 8593A, HP 8593E | 58 ms/401 points |
| HP 8594A, HP 8594E | 58 ms/401 points |
| HP 8595A, HP 8595E | 58 ms/401 points |
| HP 8596E | 58 ms/401 points |

**HP 8590 A and B Series**
**System Characteristics (7 of 8)**

| Configuration: HP 8514A, HP 85630A, and spectrum analyzer with tracking generator option | Amplitude Accuracy (After normalization, with pre-normalized reference trace starting at reference level.) |
|---|---|
| **HP 8590B, HP 8591A, HP 8593A, HP 8594A, HP 8595A** | |
| log incremental | ±0.2 dB/2 dB, 0 to -70 dB from ref. level |
| log max. cumulative | ±0.75 dB, 0 to -60 dB from ref. level<br>fl.0 dB, 0 to -70 dB from ref. level |

**HP 8590 D and E Series**
**System Characteristics (8 of 8)**

| Configuration: HP 85714A, HP 85630A, and spectrum analyzer with tracking generator option | Amplitude Accuracy (After normalization, with pre-normalized reference trace starting at reference level.) |
|---|---|
| **HP 8590D, HP 65901, HP 8591E, HP 8593E, HP 8594E, HP 8595E, HP 8596E** | |
| log incremental | ±0.4 dB/4 dB, 0 to -70 dB from ref. level |
| log max. cumulative | 0 to -70 dB from ref. level |
| 1 kHz RBW | ±0.4 dB + 0.01 × (dB from ref. level) |
| 3 kHz to 3 MHz RBW | ±0.3 dB + 0.01 × (dB from ref. level) |

# Concepts

# Concepts

The concepts discussed in this chapter help you evaluate the measurement uncertainties inherent in scalar test setups. The information is technical in nature and is not necessary for operating the scalar analyzer. It is provided for those who wish a more in-depth understanding of scalar measurements.

# Transmission measurement uncertainty

Transmission measurement uncertainty is composed primarily of relative amplitude accuracy (flatness, display fidelity) and the external circuit mismatch.

Normalization removes flatness uncertainties. Display fidelity in the HP 8590 Series spectrum analyzers is good (greater than $\pm 0.2$ dB/2 dB but not more than a maximum of fl.O dB over a 70 dB range). The major causes of transmission measurement uncertainties, then, result from external mismatch among *source,* receiver, and DUT. These external mismatch uncertainties arise at calibration and measurement.

## Basic calculation review

You should be familiar with the relationships among reflection coefficient (I'), standing wave ratio (VSWR), and return loss:

$$\Gamma = \rho \angle \theta$$

$$\text{VSWR} = \frac{1+\rho}{1-\rho}$$

$$\rho = \frac{\text{VSWR}-1}{\text{VSWR}+1}$$

$$\text{Return Loss} = -20 \log \rho$$

Maximum mismatch error in dB is expressed by

$$MME = 20 \log(1 \pm \rho_1 \rho_2),$$

*where..*

$\rho_1$ and $\rho_2$ are the scalar reflection coefficients at the points of connection.

**Reflectometer calculator**

The HP Reflectometer Calculator (HP Part Number 5952-0948) makes it easy to determine equivalents among $\rho$, VSWR, and return loss.

Reflection coefficient is a vector (complex) quantity. In a scalar system like the HP 85714A, we cannot measure phase of a particular $\Gamma$ and then account for it in our error analysis and correct for it in the measurement. We can, however, ignore phase, determine worst case caused by interaction of two reflection coefficients (two $\rho$'s), then know that actual measurement error is between zero and worst case. Worst case is the same as MME in the above expression.

In the following example, all results are maximum possible errors. We want to calculate the maximum mismatch error of a filter measurement at its 3 dB point. The final error window will combine the MME at calibration and the MME at measurement. Assume a source with $\rho_s$ = 0.2 (or 1.5 VSWR) and a receiver with a $\rho_r$ = 0.13 (or 1.3 VSWR). Given these two $\rho$'s, our MME equation yields a possible calibration (*thru* measurement) error window of $\pm 0.23$ dB.

Now we must calculate possible errors with the DUT inserted between the source and receiver. The source $\rho_s$ will interact with the DUT input $\rho_{d1}$; the receiver $\rho_r$ will interact with the DUT output $\rho_{d2}$. Therefore, we must calculate two MME's, then add them together to arrive at the measurement error window.

At the 3 dB point the filter reflects half of the input power, so reflection coefficients $\rho_{d1}$ and $\rho_{d2}$ equal 0.707 (or 5.8 VSWR). Our MME equation yields the input and output mismatch errors, respectively: + 1.15/– 1.3 dB and + 0.76/–0.84 dB. We now add these error windows to get the MME at measurement (+ 1.91/–2.14 dB):

$$1.15 + 0.76 = +1.91\,dB$$

$$-1.3 + (-0.84) = -2.14\,dB.$$

To get the total uncertainty of the measurement, we subtract the negative measurement number from the positive calibration number, and we subtract the positive measurement number from the negative calibration number (We subtract because measurement error was the denominator of a linear equation before converting to dB.):

$$+.23 - (-2.14) = +2.37\ dB$$

$$-.23 - (+\ 1.91) = -2.14\ dB$$

Thus, for our 3 dB point filter measurement, our MME is + 2.37/−2.14 dB—we might measure anything from 0.86 to 5.37 dB.

The error can be worse if hardware constraints necessitate additional cables and/or adapters between source and/or receiver and the DUT. The source is at the end of its cable/adapter; the receiver input is at the end of its cable/adapter, so we must consider the mismatches at these points rather than at the panel connectors. Effective mismatch becomes worse.

To determine effective mismatches, multiply the VSWR values. For example, if the *lossless* cables and adapters each have VSWR's of 1.1, the source VSWR becomes

$$1.5 \times 1.1 \times 1.1 = 1.8\ (or\ 0.29\rho)$$

and the receiver VSWR becomes

$$1.3 \times 1.1 \times 1.1 = 1.57\ (or\ 0.22\rho).$$

With these numbers, the maximum mismatch errors at calibration and at DUT input/output at measurement are +0.54/−0.58, + 1.6/−2.0, and + 1.27/− 1.5 dB, respectively.

**low-loss devices**

When the OUT is a low-loss device, we must also account for the interaction between source and receiver when the DUT is connected. We ignore this interaction at the 3 dB point of our filter, because it would add only about 0.2 dB.

Also, we assume that the OUT input and output connectors are the same type, opposite sex. If not, you must insert an adapter at calibration, then remove it when you insert the OUT. A high quality adapter's effect on uncertainty is small, thus it is not included here.

# Enhancing transmission measurement accuracy

Attenuators (pads)

The simplest way to improve the situation is to place well-matched Exed attenuators (with DUT compatible connectors) at the source output and at the receiver input. Connect the attenuators at the ends of the cables/adapters discussed above, *not* at the tracking generator and analyzer panel connectors.

For example, given 10 dB pads with *p's* of 0.05 (or 1.1 VSWR), the source and receiver reflection coefficients (assuming the above cables and adapters) become 0.078 (or 1.17 VSWR) and 0.071 (or 1.16 VSWR) respectively. The maximum calibration, input, and output mismatch errors then become ±0.05, +0.48/−0.5, + 0.43/−0.44 dB, respectively-dramatic improvements.

If we need accurate measurement of points farther down the filter skirts, e.g. the 6, 10, 20 dB points, the reflection coefficient of the Elter approaches unity (infinite VSWR). In such cases our 10 dB pads may not give us enough isolation, leaving us with errors in excess of 1 dB. Fortunately, the HP 85714A has plenty of dynamic range, so we can often afford to use some of it to enhance accuracy. Using 20 dB pads totally masks source and receiver mismatches, for all practical purposes, and leaves just the *p's* of the pads themselves.

Directional coupler/detector

Another way to improve source match, with essentially no loss of power, is to use a directional coupler/detector in an external leveling loop. In this case the output of the coupler becomes the output of the source. The effective source match in this case becomes

$$\rho_{source} = \sqrt{d^2 + (0.75 \times \rho_c)^2}$$

*where..*

d equals the coupler directivity

$\rho_c$ equals coupler main line reflection coefficient

0.75 is empirically derived

For a coupler with 30 dB directivity (equivalent to 0.03 *p)* and 0.07 $\rho$ (1.15 VSWR), source mismatch becomes 0.06 $\rho$ (or 1.13 VSWR), a little better than we achieved using the 10 dB pad above.

Two-resistor splitter

Instead of a coupler, we could use a two-resistor splitter in the leveling loop. Such a splitter has no resistors in the input arm and a series 50-ohm resistor in each of the output arms. The leveling detector connects to one of the resistive arms. The output connector on the other resistive arm becomes the effective source port at which we measure source mismatch. The leveling action makes the junction of the input and output arms a virtual RF ground. As a result, the source mismatch is dependent upon the quality of the resistor in the output arm. For example, the HP 11667A has an equivalent source VSWR of 1.1 from dc to 4 GHz, 1.2 up to 8 GHz, and 1.33 up to 18 GHz. Note the wide frequency range of the splitter-a significant advantage over a coupler. In terms of source power, the splitter does cost 6 dB, which is more than a coupler but less than a pad.

# Reflection measurement uncertainties

Instrumentation contributes the same uncertainties to reflection measurements as indicated above for transmission measurements. In this section, we shall focus on the uncertainties caused by the external circuit. However, there is more than just mismatch to consider. The error expression for reflection is

$$\mathrm{Ap} = A + B\rho_d + C\rho_d^2,$$

*where..*

Ap equals the measurement uncertainty

A equals the directivity of the coupler or bridge

B equals the calibration error and frequency response

C equals the source mismatch

$\rho_d$ is the reflection coefficient of the DUT

The coefficients in the above expression are linear terms, but coupler or bridge directivity is usually expressed in dB, as is frequency response, and source mismatch is often expressed in VSWR, so all of these must be converted to linear values. In addition, measurement results from reflectometer systems such as the HP 85714A are in dB of return loss, and it is common to express uncertainty in dB:

$$Uncertainty = 20\log(1 \pm \mathrm{Ap}).$$

The HP Reflectometer Calculator (HP Part Number 5952-0948) makes it easy to determine equivalents among p, VSWR, and return loss.

## The A term

Let's look at the A term in the error expression first. If the measurement port of a directional coupler or bridge is terminated with a perfect load, there should be no signal at the detector port because there is no reflection from the load. (In this case the spectrum analyzer is the detector.) However, since no coupler or bridge is perfect, there is always some signal at the detector port. The level of this signal is a measure of the directivity of the coupler or bridge and is generally expressed in dB. For example, if we put a perfect load on our coupler and measure a 30 dB return loss, that really means that our coupler has 30 dB directivity.

The directivity signal is thus a constant signal at the detector port that adds vectorially to the desired reflection signal that we wish to measure, producing an error in the measurement. To produce an error of no more than 1 dB, the directivity signal must be at least 20 dB below the signal to be measured. In other words, the directivity of the coupler or bridge must be at least 20 dB better than the return loss of the device to be measured. If we were testing devices with return losses of about 10 dB (1.92 VSWR), we would need a coupler or bridge with 30 dB directivity for no more than 1 dB of error just due to directivity.

The error expression tells us that the B and C terms become small as the match of the DUT improves. So directivity of the coupler or bridge becomes the limiting factor when measuring high-return-loss devices. Unless we take extra-ordinary steps in the measurement process that are beyond the scope of this discussion, the only thing that we can do to improve measurement results is to use a better coupler or bridge.

*A* word of caution-Use a coupler/bridge with a test-port connector that matches the DUT. Any adapters have their own reflections and degrade the directivity of the coupler/bridge. For example, a perfect coupler with an adapter having a 1.065 VSWR (30 dB return loss, 0.032 $\rho$) has an effective directivity of 30 dB. A coupler with 30 dB directivity would have an effective directivity ranging anywhere from infinity to 24 dB, depending upon the phase of the reflection from the adapter relative to that of the directivity signal of the coupler itself.

## The C term

Next, let's look at the source match term, C. As far as the DUT is concerned, the source port is the measurement port of the coupler or bridge, i.e. the port to which the DUT is attached. Any reflection from the DUT (the signal that we wish to measure) flows back toward the source, and, unless the match of the source is perfect, a part of this signal is re-reflected back toward the DUT.

The DUT reflects part of this re-reflected signal just as it did part of the original signal. If $\rho_d$ is the reflection of the DUT and C is the reflection coefficient of the source, then a first-order approximation of the measured signal $\rho_m$ is

$$Pm = \rho_d \times C \times \rho_d = C\rho_d^2.$$

This term becomes important when measuring devices with high reflection coefficients (low return losses). For example, we might want to measure the 6 dB return-loss points. In this case reflection coefficient is 0.5, so $\rho_d^2$ is 0.25. For a good measurement, then, we need to minimize the mismatch of the source. When using a coupler for reflection measurements, we usually use a dual coupler (two couplers in the same physical package) and use one of the couplers in a leveling loop. We can then calculate effective source match just as was done in the transmission discussion above. Using the same numbers as in the transmission example (0.06 $\rho$, 1.13 VSWR), the uncertainty in determining the 6 dB return loss point due to source mismatch is

$$Ap = 0.06 \times 0.25 = 0.015, \textit{ or}$$

$$20\log(1 \pm \Delta\rho) = \pm 0.13\ dB.$$

Once again, it is best to use a coupler/bridge with a measurement port that matches the connector type of the DUT because an adapter degrades source match. We get effective source mismatch by multiplying source VSWR without the adapter by the VSWR of the adapter. Using the same adapter that we used above to determine effective directivity, we get a source mismatch of

$$source\ mismatch = VSWR_1 \times VSWR_2$$

$$source\ mismatch = 1.13 \times 1.065$$

$$source\ mismatch = 1.2\ VSWR\ (or\ 0.09\ \rho)$$

The effective source match characteristic of the HP 85630A is 1.46 VSWR (0.19 $\rho$), and the uncertainty due to source mismatch only is

$$\Delta\rho = 0.19 \times 0.25 = 0.047, \text{ or}$$

$$20\log(1 \pm \mathrm{Ap}) = +0.38/-0.40\ dB.$$

## The B term

Finally, let's look at the B term. This term includes calibration uncertainty and frequency response (as well as instrument uncertainty, which we are ignoring in this discussion). As was the case in transmission, frequency response can be removed with trace arithmetic. The calibration uncertainty also can be removed with trace arithmetic, but we must take a few extra steps to insure that it is.

In a reflection measurement, we compare the signal reflected from a DUT to the signal incident upon the DUT. To get a measure of the incident signal, we connect a device that reflects all of the incident signal to the measurement port of our coupler or bridge and use this reflected signal as our reference that represents a reflection coefficient of unity (1.0). The usual calibration device is a short circuit.

If our system were perfect, we would indeed get an exact measure of the unity reflection from the short. However, from the above, we know that there are two other signals that add vectorially to the unity signal: a directivity signal and a multiple-reflection signal resulting from source mismatch. So the calibration uncertainty part of the B term is somewhere between zero and the algebraic sum of A and C, depending upon the phase angles of A and C relative to the unity (actually – 1) reflection from the short. Since the HP 85714A is a scalar system, it measures the absolute value of the combination:

$$|-1 + A + C|, \text{ or } +1 - A - C$$

In most analyzer/tracking-generator systems, we must live with the calibration uncertainty because there is no provision for removing it.

The HP 85714A allows us to use a second standard, an open, to eliminate A and C from the calibration trace. The reflection from an open is also unity, but in this case it is + 1 because the reflected signal is in phase with the incident signal rather than 180 degrees out of phase as it is for the short (hence the -1). As is the case with the short, a calibration trace based on an open also includes A and C:

$$|+1 + A + C|$$

To eliminate A and C we can average the two calibration traces and end up with just the unity value that we wanted. Thus the two step calibration process for the HP 85714A: first calibrate with an open and store that trace; then replace the open with a short and recalibrate. The HP 85714A automatically calculates the mean of the short and open calibrations and stores the result.

The stored open/short average also includes the inherent system frequency response, so we can eliminate the B term completely, and the error expression becomes

$$\text{Ap} = A + C\rho_d^2.$$

Still, coupler/bridge directivity (A) is critical for accurate measurement of well matched devices (high return loss, low VSWR or $\rho$), while source match (C) becomes the critical factor for low return-loss (high VSWR or $p$) measurements, for example, the 3 dB point of our filter.

# If You Have a Problem

# If You Have a Problem

Your spectrum analyzer, with its scalar measurements personality, is built to provide dependable service. It is unlikely you will experience a problem, but in the event something goes wrong, refer to the following sections:

- If you can't install the HP 85714A
- If you suspect a problem with the test set
- If DISPLAY UNDER-RANGE or DISPLAY OVER-RANGE is displayed
- If you can't use dual-display mode
- If you can't measure MAG S11, VSWR, or MAG S21
- If BW MEAS measurement shows UNCAL

# Start here

Perform the following steps to isolate any problem. If the problem still is not resolved, call your nearest HP Sales and Service Office.

1. Be sure that the spectrum analyzer's firmware date code is 10.26.90 or later. This is not the revision number of the HP 85714A.
2. Reinstall the HP 85714A scalar measurements personality using the instructions in Chapter 1.
3. Refer to the contents of this chapter for common problems and their solutions.
4. Complete all the basic checks for the spectrum analyzer listed in the spectrum analyzer's installation and verification manual.

# If you can't install the HP 85714A

- Check that the card is correctly installed.

  The arrow on the card must line up with the arrow on the card slot

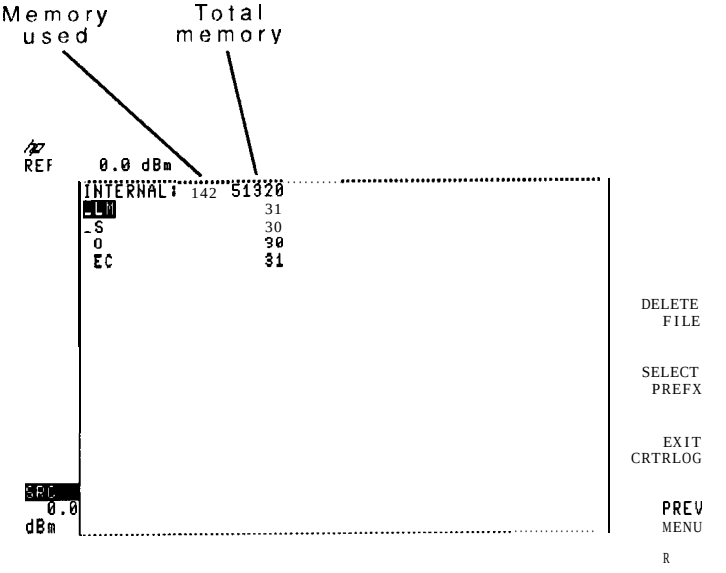
- Check the available user memory.

  The following message is displayed if available memory is not enough to hold the HP 85714A:

INVALID SYMTABENTRY: SYMTAB OVERFLOW

## To check available user memory

1. Press the (RECALL) key.
2. Press the INTRNL CRD softkey so that INTRNL is underlined.
3. Press the CATALOG INTRNL then CATALOG ALL softkeys.
4. The user memory information is shown at the top of the screen after the text INTERNAL : . Available memory is the total memory minus the memory already used. See the following figure. Available memory must be at least 47000 bytes.



## To increase user memory

To make available all user memory, press the CONFIG key followed by the MORE 1 of 3 and DISPOSE USER MEM softkeys.

If you use this quick method of increasing memory, all user entered data, downloadable programs, and any other measurement personalities will be erased.

To make available user memory by erasing selected downloadable programs, do the following:

1. Press the RECALL key.
2. Press the INTRNL CRD softkey so that INTRNL is underlined.
3. Press the CATALOG INTRNL then MORE 1 of 2 softkeys.
4. Press the CATALOG DLP softkey.
5. Use the front-panel knob to select the downloadable program for erasure then, press the DELETE FILE softkey.

## If you suspect a problem with the test set

- Check that the TEST SET YES NO softkey is pressed so that YES is underlined. Press (CONFIG), MORE 1 of 3 , and MORE 2 of 3 to locate the softkey.
- Check the rear-panel AUX INTERFACE and RF cables are correctly connected. Always remove line power before connecting the AUX INTERFACE cable.
- Check that the spectrum analyzer and tracking generator operate correctly without the HP 85630A scalar transmission/reflection test set or HP 85714A scalar measurements personality.
- Check the HP 85630A scalar transmission/reflection test set's manual for information on verifying test set operation.

## To check proper cable installation

Refer to Chapter 1, and perform Step 1 "Connect the optional HP 85630A Test Set".

## To check spectrum analyzer operation

The following procedure tests the spectrum analyzer and tracking generator by running the tracking generator's self-calibration routine. For more information on the routine, refer to the spectrum analyzer's operation manual.

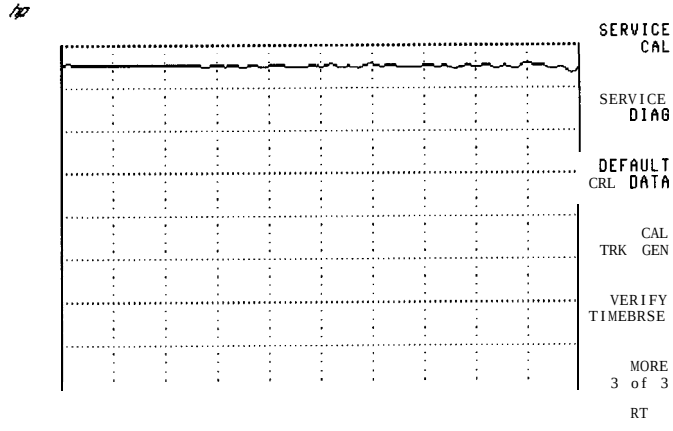
1. Press the front-panel (MODE) key.
2. Press the SPECTRUM ANALYZER softkey.

This exits the scalar measurements personality mode.

3. Connect a cable between the front-panel RF OUT and INPUT connectors.
4. Press the (CAL) key.
5. Press the MORE 1 of 3 , MORE 2 of 3 , and then CAL TRK GEM softkeys.

Towards the end of the calibration routine, the display should look similar to the following figure. Notice the level response near the top of the display. This shows a level tracking generator output at the proper power level for the test.

If the calibration runs without any errors, refer to the HP 85630A scalar transmission/reflection test set's manual for information on verifying the test set's operation and service.



# If DISPLAY UNDER-RANGE or DISPLAY OVER-RANGE is displayed

Display calibration has a finite amplitude range. When a response goes beyond the calibrated limit, the scalar analyzer displays these messages.

## To solve this problem

- Change the amplitude scale and recalibrate the measurement.
- View the Calibration Limits

  1. Press the front-panel CAL key.
  2. Press the More 1 of 2 softkey.
  3. To show the maximum level of calibrated display, press MAX RNG ON OFF so that ON is underlined.
  4. To show the minimum level of calibrated display, press MIN RNG ON OFF so that ON is underlined.

## If you can't use dual-display mode

- Check that the HP 85630A scalar transmission/reflection test set is properly installed.

  Viewing both the transmission and reflection response simultaneously requires an HP 85630A scalar transmission/reflection test set.

- Check that the scalar analyzer is configured for the test set.

  The following message is displayed if the scalar analyzer is not configured for the test set:

  85630A Test Set Configuration Required

## To install the test set

Perform the installation instructions included in step 6 of Chapter 1.

## To configure the scalar analyzer for the test set

1. Press the (MODE) and then the SCALAR ANALYZER softkey to enter the scalar analyzer mode.
2. Press the (CONFIG) key.
3. Press the MORE 1 of 3 and then MORE 2 of 3 softkeys.
4. Press the TEST SET YES NO softkey so that YES is underlined.

# If you can't measure MAG S11, VSWR, or MAG S21.

- Check that you've calibrated the response.

  These measurements require a normalized display.

- Check (for MAG S11 and VSWR measurements) that the HP 85630A scalar transmission/reflection test set is properly installed.

  Measuring MAG S11 and VSWR requires an HP 856308 scalar transmission/reflection test set.

- Check (for MAG S11 and VSWR measurements) that the scalar analyzer is configured for the test set.

  The following message is displayed if the scalar analyzer is not configured for the test set:

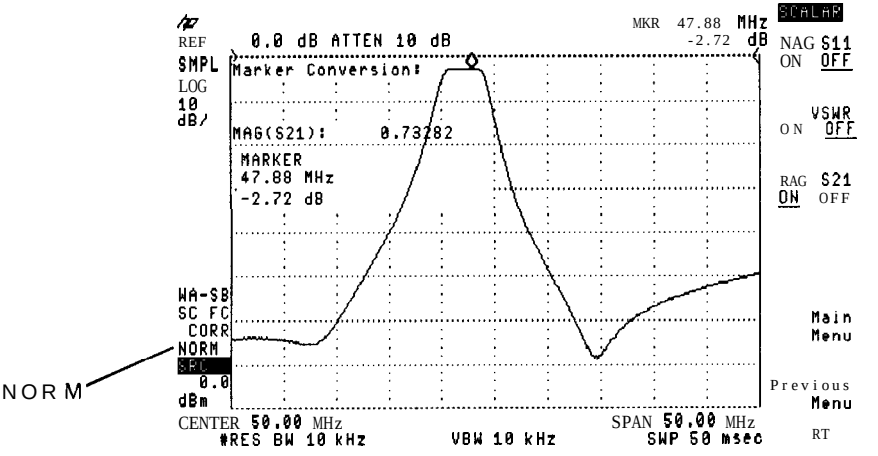
  `85630A Test Set Configuration Required`

## To install the test set

Perform the installation instructions included in step 6 of Chapter 1.

## To check that you've calibrated the response

If the display is normalized, the text NORM appears at the lower-left corner of the display.

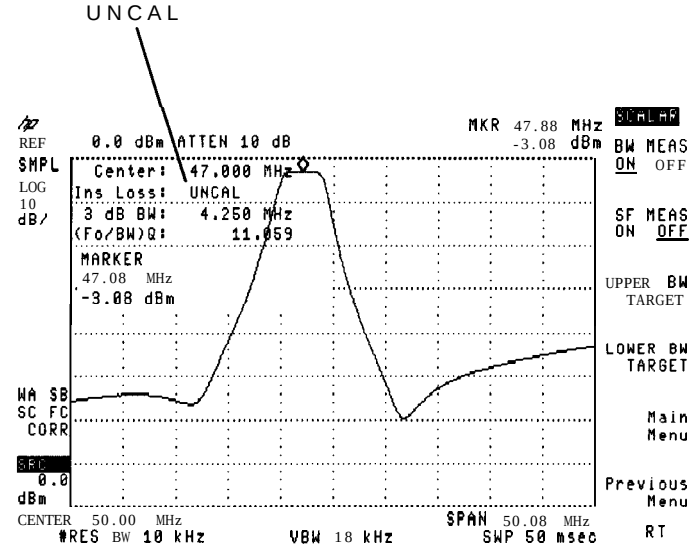



## To configure the scalar analyzer for the test set

1. Press the (MODE) and then the SCALAR ANALYZER softkey to enter the scalar analyzer mode.
2. Press the (CONFIG) key.
3. Press the MORE 1 of 3 and then MORE 2 of 3 softkeys.
4. Press the TEST SET YES NO softkey so that YES is underlined.

# If BW MEAS measurement shows UNCAL

The insertion loss results of an automatic bandwidth measurement requires the displayed response to be calibrated.




## To solve this problem

Calibrate the display as described in Chapter 3.

# Glossary

# Glossary

**absolute amplitude accuracy**
The degree of correctness or uncertainty (expressed in either volts or dB power). It includes relative uncertainties plus calibrator uncertainty. For improved accuracy, some spectrum analyzers specify frequency response relative to the calibrator as well as relative to the midpoint between peak-to-peak extremes.

**active function**
The active function is the instrument's feature currently selected for use. It may be a key selection or remote-programming command.

**active function readout**
The area of a display screen where the active function and its state are displayed. The active function is the one that was completed by the last key selection or remote-programming command.

**active marker**
The marker on a trace that can be repositioned by front-panel controls or programming commands.

**active trace**
The trace (commonly A, B, or C) that is being swept (updated) with incoming signal information.

**amplitude accuracy**
The general uncertainty of a spectrum analyzer amplitude measurement, whether relative or absolute.

**ASCII**
The acronym for American Standard Code for Information Interchange. It is an eight-part code (7 bits plus parity check) used for data (information) interchange. An ASCII value is a specific combination of bits ranging from 0 to 255 that represent characters in machine language that computers and controllers can understand.

**attenuation**
A general term used to denote a decrease of signal magnitude in transmission from one point to another. Attenuation may be expressed as a scalar ratio of the input to the output magnitude in decibels.

**auxiliary interface**
A spectrum analyzer rear-panel connector that provides control lines and power for external equipment.

**bandwidth selectivity**
This is a measure of the analyzer's ability to resolve signals unequal in amplitude. It is the ratio of the 60 dB bandwidth to the 3 dB bandwidth for a given resolution filter (IF). Bandwidth selectivity tells us how steep the filter skirts are. Bandwidth selectivity is sometimes called shape factor.

**battery-backed RAM**
Random access memory (RAM) data retained by a battery. RAM memory cards can contain data that is maintained with a battery. Refer also to nonvolatile memory.

**broadband response**
A signal whose spectrum is wider than the resolution bandwidth of a spectrum analyzer, and whose repetition frequency is lower than the bandwidth of the spectrum analyzer. Notice that it is a combination of signal and receiver characteristics that determines when a signal is classified as broadband. For refining incoming signal responses, select narrower spans and bandwidths. The following checks can help verify whether or not the response is broadband:

- Change the resolution bandwidth. The displayed amplitude should change.
- Change the sweep time. The spacing of the responses on the display should change as you change the sweep time.
- Change the span. The spacing of the responses should not change. They should be independent of frequency span.
- Change the video bandwidth. If the video bandwidth is made narrower than the resolution bandwidth, the displayed amplitude of the responses should decrease.

**card reader**
See memory card

**character set**
The set of elementary symbols. These normally include both alpha and numeric codes, plus punctuation or any other symbol which may be read, stored, or written and used for organization, control, or representation of data.

**command**
A set of instructions that are translated into instrument actions. The actions are usually made up of individual steps that together can execute an operation. Generally, for spectrum analyzers it is a sequence of code that controls some operation of a spectrum analyzer. These codes can be keyed in via a controller, or computer. Refer also to function.

**continuous sweep mode**
The analyzer condition where traces are automatically updated each time trigger conditions are met.

**default**
The preset conditions, options, or parameters of an instrument. The default state may be changed by choosing key selections or writing programming commands to use other conditions.

**delta marker**
An analyzer mode in which a fixed reference marker is established, then a second active marker becomes available so it can be placed anywhere along the trace. A readout indicates the relative frequency separation and amplitude difference between the reference and active markers.

**display dynamic range**
The maximum dynamic range over which both the larger and smaller signal can be viewed simultaneously on the display. For analyzers with a maximum logarithmic display of 10 dB/division, the actual dynamic range may be greater than the display dynamic range. Refer also to dynamic range.

**display fidelity**
The measurement uncertainty of relative differences in amplitude on a spectrum analyzer. On purely analog analyzers (those analyzers that display trace information immediately and do not store, then recall the data to the screen), these differences are displayed on the screen and the graticule is used to evaluate the measurement. Many analyzers with digital displays (refer to digital display) have markers that can be used to measure the signal. As a result, measurement differences are stored in memory, and the ambiguity of the display is eliminated from the measurement.

**display range**
The calibrated range of the display for a particular display mode or scale factor. Refer also to log display and scale factor.

DLP
The abbreviation for downloadable program. A single programming command or a sequence of programming commands used to perform specific operations. DLPs can be made up of several functions, variables, and traces defined by the program creator. The DLP can be downloaded from one electronic storage medium into another and executed without a controller.

**dynamic range**
The power ratio (dB) between the smallest and largest signals simultaneously present at the input of an analyzer that can be measured with some degree of accuracy. Dynamic range generally refers to measurement of distortion or inter-modulation products.

**error message**
A message displayed on the screen indicating missing or failed hardware, improper user operation, or other conditions that require additional attention. Generally, the requested action or operation cannot be completed until the condition is resolved.

FFT
The abbreviation for fast Fourier transform. It is a mathematical operation performed on a time-domain signal to yield the individual spectral components that constitute the signal.

**firmware**
An assembly made up of hardware and instruction code that are integrated to form a functional set which cannot be altered during normal operation. The instruction code, permanently installed in the circuitry of the instrument, is classified as ROM (read-only memory). The firmware determines the operating characteristics of the instrument or equipment. Each firmware version is identified by a revision code number, or date code.

**frequency accuracy**
The uncertainty with which the frequency of a signal or spectral component is indicated, either in an absolute sense or relative to some other signal or spectral component. Absolute and relative frequency accuracies are specified independently.

**frequency range**
The range over of frequencies which the spectrum analyzer performance is specified. The maximum frequency range of many microwave analyzers can be extended with the application of external mixers.

**frequency resolution**
The ability of a spectrum analyzer to separate closely spaced spectral components and display them individually. Resolution of equal amplitude components is determined by resolution bandwidth. Resolution of unequal amplitude signals is determined by resolution bandwidth and bandwidth selectivity.

**frequency response**
The peak-to-peak variation in the displayed signal amplitude over a specified center frequency range. Frequency response is typically specified in terms of ±dB relative to the value midway between the extremes. It also may be specified relative to the calibrator signal.

**frequency span**
The magnitude of the displayed frequency component. Span is represented by the horizontal axis of the display. Generally, frequency span is given as the total span across the full display. Some analyzers represent frequency span (scan width) as a per-division value.

**frequency stability**
The stability of a frequency component to remain unchanged in frequency or amplitude over short- and long-term periods of time. Stability refers to the local oscillator's ability to remain fixed at a particular frequency over time. The sweep ramp that tunes the local oscillator influences where a signal appears on the display. Any long-term variation in local oscillator frequency (drift) with respect to the sweep ramp causes a signal to shift its horizontal position on the display slowly. Shorter-term local oscillator instability can appear as random FM or phase noise on an otherwise stable signal.

**front-panel key**
Keys, typically labeled, and located on the front panel of an instrument. The key labels identify the function the key activities. Numeric keys and step keys are two examples of front- panel keys.

**full span**
A mode of operation in which the spectrum analyzer scans the entire frequency band of an analyzer.

**function**
The action or purpose which a specific item is intended to perform or serve. The spectrum analyzer contains functions that can be executed via front-panel key selections, or through programming commands. The characteristics of these functions are determined by the firmware in the instrument. In some cases, a DLP (downloadable program) execution of a function allows you to execute the function from front-panel key selections.

**gain compression**
The signal level at the input mixer of a spectrum analyzer where the displayed amplitude of the signal is a specific number of dB too low due just to mixer saturation. The signal level is generally specified for 1 dB or 0.5 dB compression and is usually between -3 dBm and -10 dBm.

**hard copy**
Information or data printed onto paper as opposed to its being stored on disk or in the instrument's memory.

**HP-IB**
The abbreviation for Hewlett-Packard Interface Bus. It is a Hewlett-Packard proprietary parallel interface that allows you to "daisy-chain" more than one device to a port on a computer or instrument.

**input attenuator**
An attenuator between the input connector and the Erst mixer of a spectrum analyzer (also called an RF attenuator). The input attenuator is used to adjust the signal level incident to the Erst mixer, and to prevent gain compression due to high-level or broadband signals. It is also used to set the dynamic range by controlling the degree of internally-generated distortion. For some analyzers, changing the input attenuator settings changes the vertical position of the signal on the display, which then changes the reference level accordingly. In Hewlett-Packard microprocessor-controlled spectrum analyzers, the IF gain is changed to compensate for changes in input attenuator settings. Because of this, the signals remain stationary on the display, and the reference level is not changed.

**input impedance**
The terminating impedance that the analyzer presents to the signal source. The nominal impedance for RF and microwave analyzers is usually 50Ω. For some systems, such as cable TV, 75Ω is standard. The degree of mismatch between the nominal and actual input impedance is called the VSWR (voltage standing wave ratio).

**limit line**
A test limit made up of a series of line segments, positioned according to frequency and amplitude within the spectrum analyzer's measurement range. Two defined limit lines may be displayed simultaneously. One sets an upper test limit, the other sets a lower test limit. Trace data can be compared with the limit lines as the spectrum analyzer sweeps. If the trace data exceeds either the upper or lower limits, the spectrum analyzer displays a message or sounds a warning, indicating that the trace failed the test limits.

**limit-line file**
The user-memory Ele that contains the limit-line table entries. Limit lines are composed of frequency and amplitude components that make up a trace array and this data is stored in the Ele. The limit-line Ele feature is available on spectrum analyzers that are capable of limit-line operation. Refer also to limit line.

**limit-line table**
The line segments of a limit line are stored in the limit-line table. The table can be recalled to edit the line segments, then restored in the limit-line file. Refer also to limit line.

**log display**
The display mode in which vertical deflection is a logarithmic function of the input-signal voltage. Log display is also referred to as logarithmic mode. The display calibration is set by selecting the value of the top graticule line (reference level), and scale factor in volts per division. On Hewlett-Packard analyzers, the bottom graticule line represents zero volts for scale factors of 10 dB/division or more. The bottom division, therefore, is not calibrated for those analyzers. Analyzers with microprocessors allow reference level and marker values to be indicated in dBm, dBmV, dB$\mu$V, volts, and occasionally in watts. Nonmicroprocessor-based analyzers usually offer only one kind of unit, typically dBm.

**marker**
A visual indicator we can place anywhere along the displayed trace. A marker readout indicates the absolute value of the trace frequency and amplitude at the marked point. The amplitude value is displayed with the currently selected units. Refer also to delta marker.

**maximum input level**
The maximum signal power that may be safely applied to the input of a spectrum analyzer. Typically 1 W (-30 dBm) for Hewlett-Packard spectrum analyzers.

**measurement range**
The ratio, expressed in dB, of the maximum signal level that can be measured (usually the maximum safe input level) to the lowest achievable average noise level. This ratio is almost always much greater than can be realized in a single measurement. Refer also to dynamic range.

**memory**
A storage medium, device, or recording medium into which data can be stored and held until some later time, and from which the entire original data may be retrieved.

**memory card**
A small, credit-card-shaped memory device that can store data or programs. The programs are sometimes called personalities and give additional capabilities to your instrument. Typically, there is only one personality per memory card. Refer also to personality.

**menu**
The spectrum analyzer functions that appear on the display and are selected by pressing front-panel keys. These selections may evoke a series of other related functions that establish groups called menus.

**nonvolatile memory**
Memory data that is retained in the absence of an ac power source. This memory is typically retained with a battery. Refer also to battery-backed RAM.

**normalized reference level**
An amplitude level representing 0 dB deviation from a calibrated system's response. It is obtained'by subtracting the system's response from itself.

**normalized reference position**
The position on a network analyzer's display of the normalized reference level.

**parameter units**
Standard units of measure, which include the following:

| Measured Parameter | Unit Name | Unit Abbreviation |
|---|---|---|
| frequency | hertz | HZ |
| power level | decibel relative to milliwatts | dBm |
| power ratio | decibel | dB |
| voltage | volt | V |
| time | second | s |
| electrical current | ampere | A |
| impedance (resistance) | ohm | Ω |

**personality**
Applications available as Hewlett Packard products on a memory card or other electronic media that extends the capability of an instrument for specific uses. Examples include digital radio personalities and cable TV personalities.

**preamplifier**
An external, low-noise-Egure amplifier that improves system (preamplifier/spectrum analyzer) sensitivity over that of the analyzer itself.

**Q**
Q indicates the frequency selectivity of a response. The narrower the bandwidth at a given frequency, the higher the Q. It is defined by the following formula:

$$Q = \frac{f_o}{BW}$$

where:
$f_o$ is the center frequency of the displayed response.
BW is the bandwidth of the displayed response.

**query**
Any spectrum analyzer programming command having the distinct function of returning a response. These commands may end with a question mark (?). Query commands return information either to the computer or to the analyzer display.

**random-access memory**
RAM (random-access memory) or read-write memory, is a storage area allowing access to any of its storage locations. Data can be written to or retrieved from RAM, but data storage is only temporary. When the power is removed, the information disappears. User-generated information appearing on a display is RAM data.

**read-only memory**
ROM (read-only memory) that is encoded into the analyzer's Ermware. The data can be accessed (read) only; it cannot be altered by the user.

**reference level**
The calibrated vertical position on the display used as a reference for amplitude measurement in which the amplitude of one signal is compared with the amplitude of another regardless of the absolute amplitude of either.

**reflection coefficient**
A scalar measurement defined as the ratio of the reflected signal voltage to the incident signal voltage on a transmission line not terminated in its characteristic impedance. The reflected signal is typically reflected from the input of a device under test. The reflection coefficient is also referred to as the scattering parameter $S_{11}$. The reflection coefficient is defined by the following formula:

$$\Gamma = E\frac{\text{reflected}}{E_{\text{incident}}}$$

**reflection measurement**
Refer to reflection coefficient.

**relative-marker mode**
The active marker is positioned relative to the position of the reference marker. Marker readout shows amplitude, frequency, or time differences between the two markers.

**resolution**
Refer to frequency resolution.

**resolution bandwidth**
The ability of a spectrum analyzer to display adjacent responses discretely (hertz, hertz decibel down). This term is used to identify the width of the resolution bandwidth filter of a spectrum analyzer at some level below the minimum insertion-loss point (maximum deflection point on the display). The 3 dB resolution bandwidth is specified; for others, it is the 6 dB resolution bandwidth.

**return loss**
A scalar measurement on a transmission line with a mismatched load. Return loss indicates how much less the reflected power is from the incident power on the line. This is shown in the following formula:

*return loss = incident power — reflected power*

**$S_{11}$**
Refer to reflection coefficient

**$S_{21}$**
Refer to transmission coefficient

**scalar-analyzer mode**
The operating state that allows a spectrum analyzer to make network-analysis measurements. Spectrum analyzers with this ability use tracking generator functions. Measurement results are displayed in a relative-amplitude scale resulting from a variation, plus or minus, from a reference (normalized) value stored in a trace.

**scale factor**
The per-division calibration of the vertical axis of the display.

**shape factor**
Refer to bandwidth selectivity.

**single-sweep mode**
The spectrum analyzer sweeps once when trigger conditions are met. Each sweep is initiated by pressing an appropriate front-panel key, or by sending a programming command.

**softkey**
Key labels displayed on a screen or monitor which are activated by mechanical keys surrounding the display, or located on a keyboard. Softkey selections usually evoke menus that are written into the program software. Front-panel key selections determine which menu (set of softkeys) appears on the display.

**span**
Span equals the stop frequency minus the start frequency. The span setting determines the horizontal-axis scale of the spectrum analyzer display.

**span accuracy**
The uncertainty of the indicated frequency separation of any two signals on the display.

**spectrum analyzer**

A device that effectively performs a Fourier transform and displays the individual spectral components (sine waves) that constitute a time-domain signal.

**stop/start frequency**

Terms used in association with the stop and start points of the frequency measurement range. Together they determine the span of the measurement range.

**sweep time**

The time it takes the local oscillator to tune across the selected span. Sweep time directly affects how long it takes to complete a measurement. It does not include the dead time between the completion of one sweep and the start of the next. It is usually a function of frequency span, resolution bandwidth, and video bandwidth. Resolution affects sweep time in that the IF filters are band-limited circuits requiring finite times to charge and discharge. The amount of time the mixing product remains in the IF filter passband is directly proportional to the bandwidth; inversely proportional to the sweep in Hz per unit of time. The rise time of a filter is inversely proportional to its bandwidth, and if the proportionality constant "k" is included, then we can make the rise time equal the "k" divided by resolution bandwidth. Mathematically, this is represented as:

$$Time\ in\ Passband = \frac{resolution\ \ bandwidth}{(spansweep\ \ time)}$$

$$= \frac{(resolution\ \ bandwidth\ x\ sweep\ \ time)}{span}$$

$$Rise\ \ Time = \frac{k}{resolution\ \ bandwidth}$$

Solving for sweeptime:

$$Sweep\ \ Time = \frac{k\ x\ span}{resolution\ \ bandwidth^2}$$

**syntax**

The grammar rules that specify how commands must be structured for an operating system, programming language, or applications.

**test set**

A device used to measure scattering parameters on two-port or multiport devices. Test sets include couplers and optionally contain transducers and RF switches.

**trace**

A trace is made up of a series of data points containing frequency and amplitude information. The series of data points is often referred to as an array. Traces A, B, and C are the typical names of traces that analyzer displays. The number of traces is specific to the instrument.

**transmission coefficient**

A scalar measurement of a signal transmitted through a device. It is defined as the ratio of the output signal voltage over the input signal voltage of a device. (The transmission line must be terminated in its characteristic impedance.) The transmission coefficient is also referred to as the scattering parameter $S_{21}$. The transmission coefficient is defined as the ratio of the voltage at the output of a device to the voltage at the input of a device. It is shown by the following formula:

$$T = \frac{E_{output}}{E_{input}}$$

**transmission measurement**

Refer to transmission coefficient

**units**

Dimensions on the measured quantities. Units usually refer to amplitude quantities because they can be changed. In spectrum analyzers with microprocessors, available units are dBm (dB relative to 1 mW (milliwatt) dissipated in the nominal input impedance of the analyzer), dBmV (dB relative to 1 mV (millivolt)), dB$\mu$V (dB relative to 1 $\mu$V), volts, and in some analyzers watts.

**update**

To make existing information current; to bring information up to date.

**video**

A term describing the output of a spectrum analyzer's envelope detector. The frequency range extends from 0 Hz to a frequency that is typically well beyond the widest resolution bandwidth available in the analyzer. However, the ultimate bandwidth of the video chain is determined by the setting of the video filter.

**video average**

The digital averaging of spectrum analyzer trace information. It is available only on analyzers with digital displays. Each point on the display is averaged independently and the average is computed based on the number of sweeps selected by the user. The averaging algorithm applies a factor to the amplitude value of a given point on the current sweep ($1/n$, where n is the number of the current sweep); applies another factor to the previously stored average [$(n - 1/n)$] ; and combines the two for a current average. After the designated number of sweeps are completed, the factors remain constant, and the display becomes a running average.

**video bandwidth**

The cut-off frequency (3 dB point) of an adjustable low-pass filter in the video circuit. When the video bandwidth is equal to or less than the resolution bandwidth, the video circuit cannot fully respond to the more rapid fluctuations of the output of the envelope detector. The result is a smoothing of the trace, or a reduction in the peak-to-peak excursion, of broadband signals such as noise and pulsed RF when viewed in broadband mode. The degree of averaging or smoothing is a function of the ratio of the video bandwidth to the resolution bandwidth.

**video filter**

A post-detection, low-pass filter that determines the bandwidth of the video amplifier. It is used to average or smooth a trace. Refer also to video bandwidth.

**VSWR**

The VSWR (voltage standing-wave ratio) is the ratio of the minimum and maximum voltage values on a transmission line caused by reflections from a mismatch. VSWR values range from 1 (representing no reflection) to infinity (representing 100% reflection from the load). Examples of 100% reflection occurs when the transmission line is terminated with a short or open.

VSWR is related to return loss (dB) as shown in the following formula:

$$return\ loss = -20\ log(\frac{\upsilon - 1}{\sigma + 1})$$

**zero span**

The case in which a spectrum analyzer's local oscillator remains fixed at a given frequency so that the analyzer becomes a fixed-tuned receiver. In this state, the bandwidth is equal to the resolution bandwidth. Signal amplitude variations are displayed as a function of time. To avoid loss of signal information, the resolution bandwidth must be as wide as the signal bandwidth. To avoid any smoothing, the video bandwidth must be set wider than the resolution bandwidth.

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